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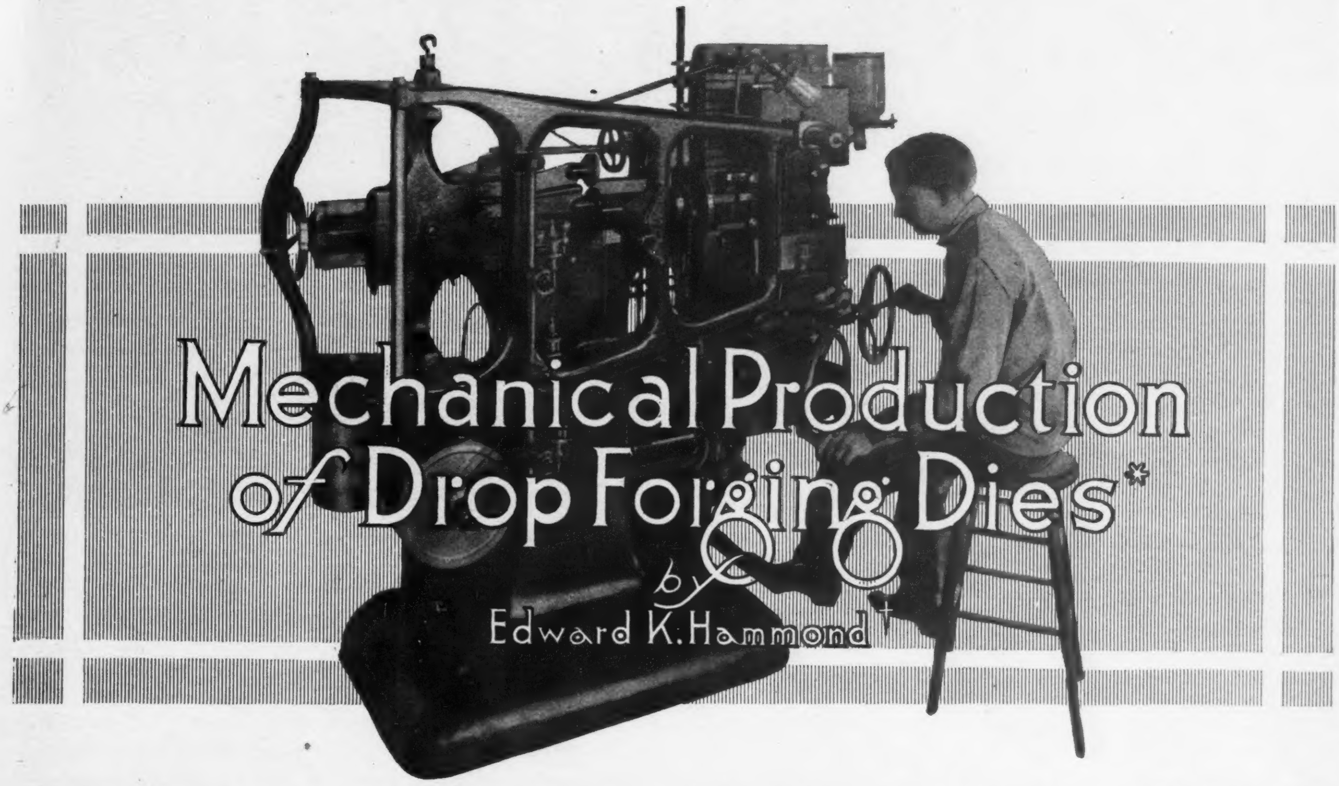


# Mechanical Production of Drop Forging Dies*

by Edward K. Hammond†

**With the constantly growing demand for drop forgings, there has been a relatively decreasing number of men able to make drop forging dies. There are several reasons for the scarcity of drop forge die-sinkers, among which may be mentioned the increasing use for drop forgings and the fact that men possessing the required ability are likely to find more remunerative employment in some broader and more congenial field. These were the general conditions when the large orders for military rifles required by the belligerent European powers were placed in this country. They created an unprecedented demand for dies required for the production of drop forged rifle parts. The supply of competent drop forge die-sinkers was practically fixed and the time required to learn the trade made it out of the question to attempt to train more men. The problem was to find some method by which the difference between the output of the existing supply of die-sinkers and the demand for drop-forge dies could be made up, and a solution of the problem was found in the automatic profiling machine. The following article gives a description of the Keller machine and method of operation, together with detailed information concerning its use in the production of drop-forge dies. While the use of this machine in making dies for the manufacture of rifle parts is referred to, the fact should be clearly understood that the method is applicable to the making of all classes of drop-forge dies and that it can also be employed in the production of other work.**

THE extensive industry which has developed in this country during the past year in manufacturing rifles for the belligent European powers has lead to a great demand for drop-forgings, and hence for the dies used in their production. This demand has been further stimulated by the fact that these war orders are taken on contracts calling for such early deliveries, that the process of manufacture must be carried on as rapidly as possible. This introduces two factors which tend to shorten the operating life of the dies: First, the intensive use of the dies themselves; second, the close limits to which the drop-forgings are held, in order that they may fit the jigs in which subsequent machining operations are performed, and that the amount of metal to be removed may be reduced to a minimum so that the machining operations may be conducted as rapidly as possible.

The actual requirements of rifle manufacturers for drop forge dies, and the number of die-sinkers which would be required to produce them by hand, will be readily appreciated from the following figures. The average military rifle contains about 25 drop-forged parts, and when several of the large factories which are manufacturing rifles for the European powers get into full swing, they will have an aggregate production of 15,000 rifles a day. A good die-sinker would require about six days to produce an average pair of dies, and their life is for making not more than 12,000 forgings. From the preceding figures it will be seen that 188 die-sinkers are required to work at their maximum rate of production at all times in order to replace the dies as fast as they are worn out.

The supply of good die-sinkers in this country has been steadily decreasing owing to the fact that it takes a mechanic of a high order to make a really efficient die-sinker. It is well known that the supply of high-grade mechanics has been inadequate for several years, and the exceptional men who have ability to become good die-sinkers are likely to find more remunerative employment in some broader line of work. As a result, there are only a limited number of competent die-sinkers available.

The demand for drop-forging dies resulting from the manufacture of rifles led to quite a lively competition in bidding for the services of die-sinkers. This was merely the means of enabling a certain manufacturer to obtain the required amount of labor by inducing men to come from some other factory; it did not have any affect on the total supply of drop-forge dies which could be turned out in a given length of time. But the use of drop-forgings in place of other materials has been steadily increasing, notable examples of their use being in the construction of automobiles, sewing machines, typewriters, and a great variety of other machinery and mechanisms. This increasing demand would soon have led to a similar condition as regards the scarcity of die-sinkers, which has been emphasized by the present rush of war business in this country.

### How the Making of Dies controls a Factory's Output

In any industry where drop-forgings are used, the making of the dies and the forgings produced in them are the first of

* For other articles on the making of drop forge dies published in MACHINERY, see also "Making Duplicate Drop-Forging Dies," by C. H. Wilcox, August, 1911; "Drop Forge Die Sinking," by Chester L. Lucas and J. W. Johnson, published in three installations in July, August, and September, 1911, and other articles there referred to.
† Associate Editor of MACHINERY.

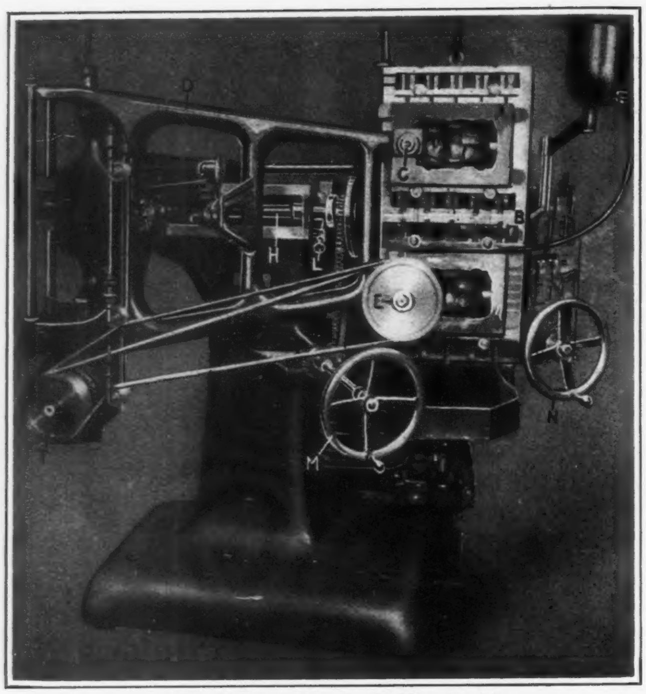


Fig. 1. The Keller Automatic Profiling Machine on which the Dies are made

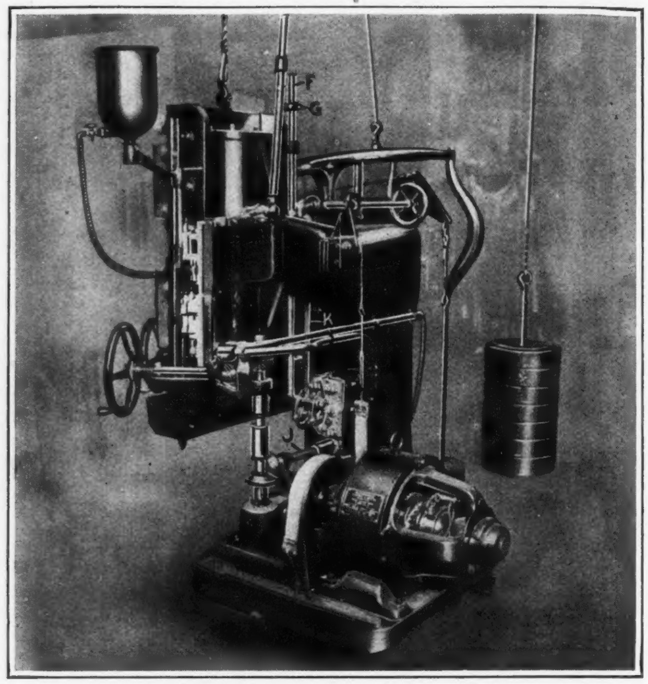


Fig. 2. Rear View of the Automatic Profiling Machine, showing Reversing Motor and Drive to Work-table and Feed

a continuous series of operations for which a large investment in mechanical equipment is necessary. Taking this point into consideration, it will be obvious that if the supply of forgings is held up, due to a lack of dies for use in the drop-forging department, other departments of the plant will show a corresponding decrease in production; and this delay is bound to result in a financial loss from several sources. These conditions have led manufacturers who use drop-forging dies to look for a more rapid method of die-making, and a satisfactory solution of the problem has been found in a machine made by the Keller Mechanical Engraving Co., 70 Washington St., Brooklyn, N. Y. Although the company's machines and methods for mechanical die-sinking have been extensively used for making dies employed in the manufacture of silverware, hardware and similar products, their application in the manufacture of drop-forge dies is comparatively recent. This explains why many manufacturers of drop-forgings and the mechanics employed in their shops are quite unfamiliar with a method of die-sinking which appears likely to have a far reaching influence in their industry. But the method is one which has been brought to a high degree of efficiency, as the result of twenty years of development work. In addition to building machines, the Keller Mechanical Engraving Co. does a large business in making all classes of dies, and machines of their own make are largely used for this work. Consequently they have been employed on a great variety of die-sinking operations, and provision has been made for working under unusual conditions which arise in most shops where intricate die work is done. As a result, the machines have been developed to a point where they are capable of giving highly satisfactory results under the most severe conditions. The machine best adapted for the production of drop-forge dies is styled an "automatic profiling machine," although this name is unsatisfactory, to a certain extent, in that the term "profiling" conveys the idea of following an outline, while as a matter of fact, this machine works automatically to produce a true reproduction of a full-sized model, both as regards its outline and surface contour. Both concave or convex work can be produced on the machine.

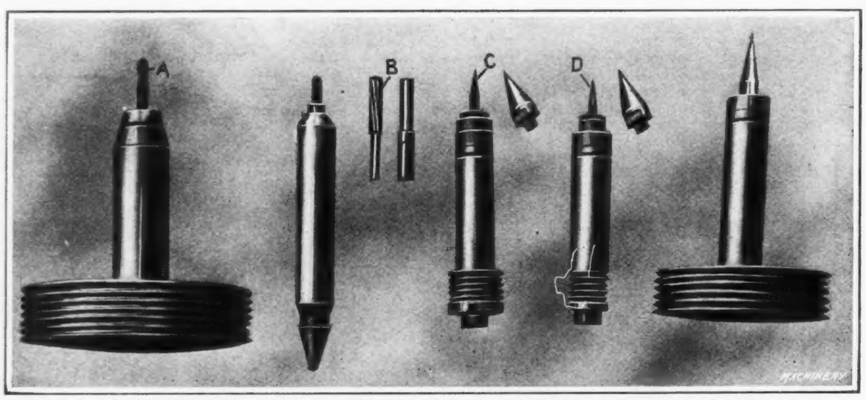



Fig. 3. Roughing Cutters A and B; and intermediate and Finish Engraving Tools C and D

The important feature of this method for the mechanical production of drop-forging dies is that the machines produce dies of the highest quality on a manufacturing basis, and that any person possessing ordinary mechanical sense can learn to operate one of these machines in a very short time. The supply of this class of labor is practically unlimited. and any number of machines can be obtained to give the required capacity in die production. The output can be further increased by running the machines in two or three shifts for twenty-four hours a day, if necessary; and as the machines work very rapidly, it will be evident that this method constitutes a very satisfactory means of controlling the time required to produce the dies used in an industry. So far as a general comparison can be made, the productive capacity of one of these machines on average work is equal to that of three men.

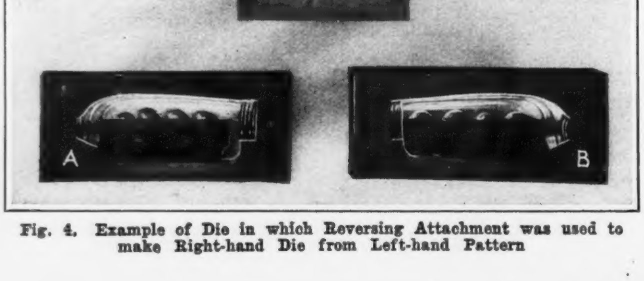



Fig. 4. Example of Die in which Reversing Attachment was used to make Right-hand Die from Left-hand Pattern

### Die-sinking on a Manufacturing Basis

In making dies by this method, all technical details of die-sinking by hand are eliminated. There is no laying out of the work and the setting-up of the machine is very simple, the die block being located by a gage which brings it into the proper relation to the pattern. The per-

sonal equation is largely eliminated from the method of manufacture as soon as the master patterns are made; and the making of these patterns is a relatively simple operation which can be handled by any patternmaker of average ability. Some patterns are first made of wood and a metal mold for use on the machine is then cast; other patterns are made direct from the metal, and in certain cases it is desirable to build the pattern up from several metal laminations. When the latter method is employed the various laminations are cut out from the sheet metal, each lamination being of the required profile of the die at a given level. These laminations are then secured firmly together to form the pattern of the die, which will subsequently be used in producing regular dies. The Keller Mechanical Engraving Co. is frequently called upon to furnish patterns to users of their machines, and is prepared to advise in regard to the most satisfactory type of pattern to use in any given case.

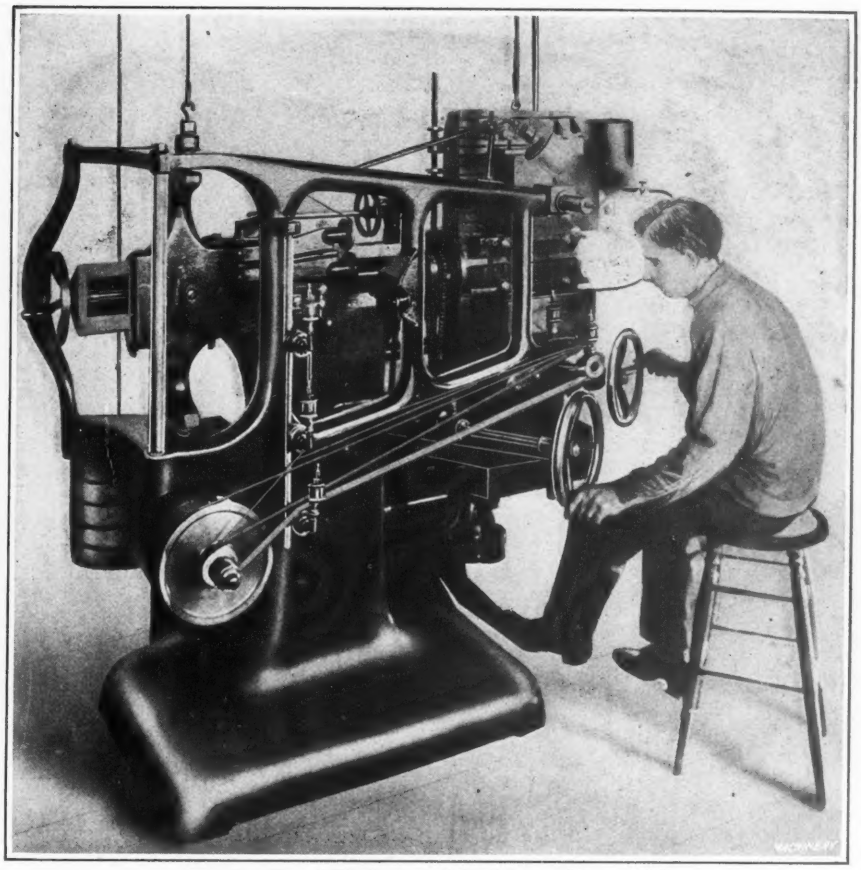


Fig. 5. Use of Hand-operated Feed in roughing out Die

There is another field in which this mechanical method of die-sinking has found a very satisfactory application, and that is in the reproduction of broken or worn dies. In the case of cracked dies, the die is clamped very firmly together so that the crack is entirely closed up. With dies from which a piece of metal has been broken away, this metal is replaced by brass, solder or some other material, so that the die is brought back to its original shape to enable it to be used as a pattern. In the case of worn dies in which the depth of the die has become too great, the method of finishing consists of removing the necessary amount of metal from the top face of the die, and then taking a cut of the required thickness to bring the die back to the standard depth. Dies made of a good grade of tool steel can be annealed and refinished in this way two or three times.

### The Keller Automatic Profiling Machine

The machine works on the profiler principle, the cutting tool being guided from a full size pattern of the die which it is required to produce. Referring to the front view of the machine shown in Fig. 1, the pattern *A* is clamped to the upper part of the work-table *B* and is engaged by a tracer point carried in the upper journal bearing *C* of the fame *D*. The cutting tool is carried in the lower bearing *E* of frame *D*. A reciprocating vertical travel is imparted to the work-table *B* which moves on a slide on the column of the machine. This causes the pattern *A* to move back and forth under the tracer point, with the result that the frame *D* swings upon the centers on which it is mounted. The frame *D* has a light counterweight attached to it, which is just sufficient to keep the tracer point in contact with the pattern at all times. Thus it will be evident that as the tracer point moves in and out in traveling over the surface of the pattern, an exactly similar movement is imparted to the cutting tool, which results in producing a die that is an exact duplicate or the pattern.

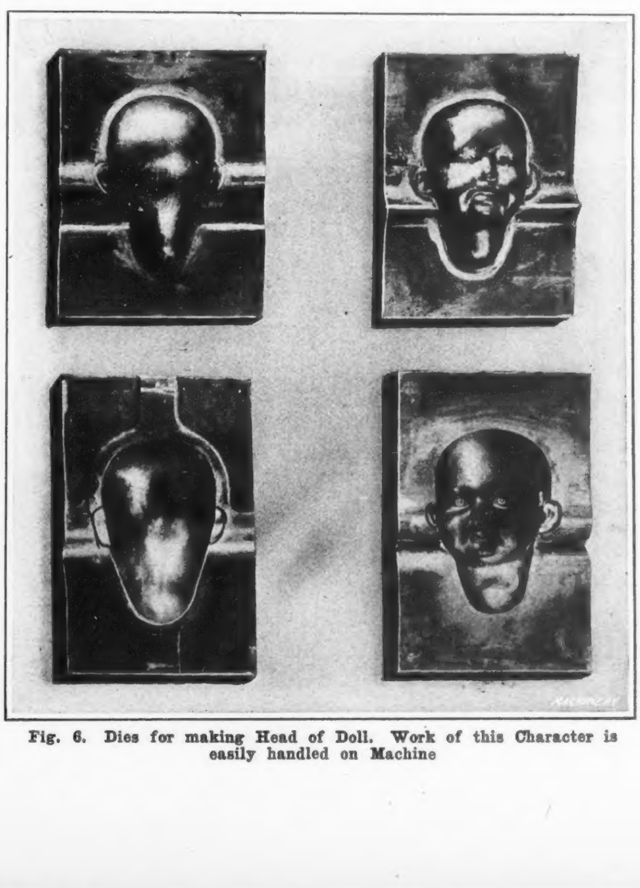


Fig. 6. Dies for making Head of Doll. Work of this Character is easily handled on Machine

In the operation of a machine of this character sensitiveness is absolutely essential, and in order to make the movements as free as possible, the work-table *B* and frame *D* are accurately counterbalanced so that there are no unnecessary frictional losses. The weight on the frame *D*, which holds the tracer point in contact with the pattern, should always be just sufficient to hold the tracer in contact with the pattern.

The reciprocating movement of the work-table is provided by a direct- or alternating-current electric motor equipped with a reversing switch, the operation of which is controlled by adjustable stops which are set on the threaded rod *F* to give the required length of travel for the tracer point so that it moves all of the way across the pattern. At the end of the table traverse in either direction, a dog carried by the table *B* engages one of the stops *G* on the threaded rod *F*, which results in throwing the switch from one set of contacts to the opposite set, to reverse the direction of rotation of the motor. The stops can be set to give any amount of table traverse from 1/4 inch up to the full capacity of the machine. The movement of the work-table is controlled by the usual form of feed-screw, and power is transmitted from the motor to the screw through a train of worm, spur and spiral gears. Change gears are provided to give the required variations in the cutting speed.

The centers on which the frame *D* is mounted are carried by a bracket which runs on the horizontal slide *H*, the movement of this bracket on the slide being obtained by a feed-screw. The power for driving the feed-screw is taken from the same motor which

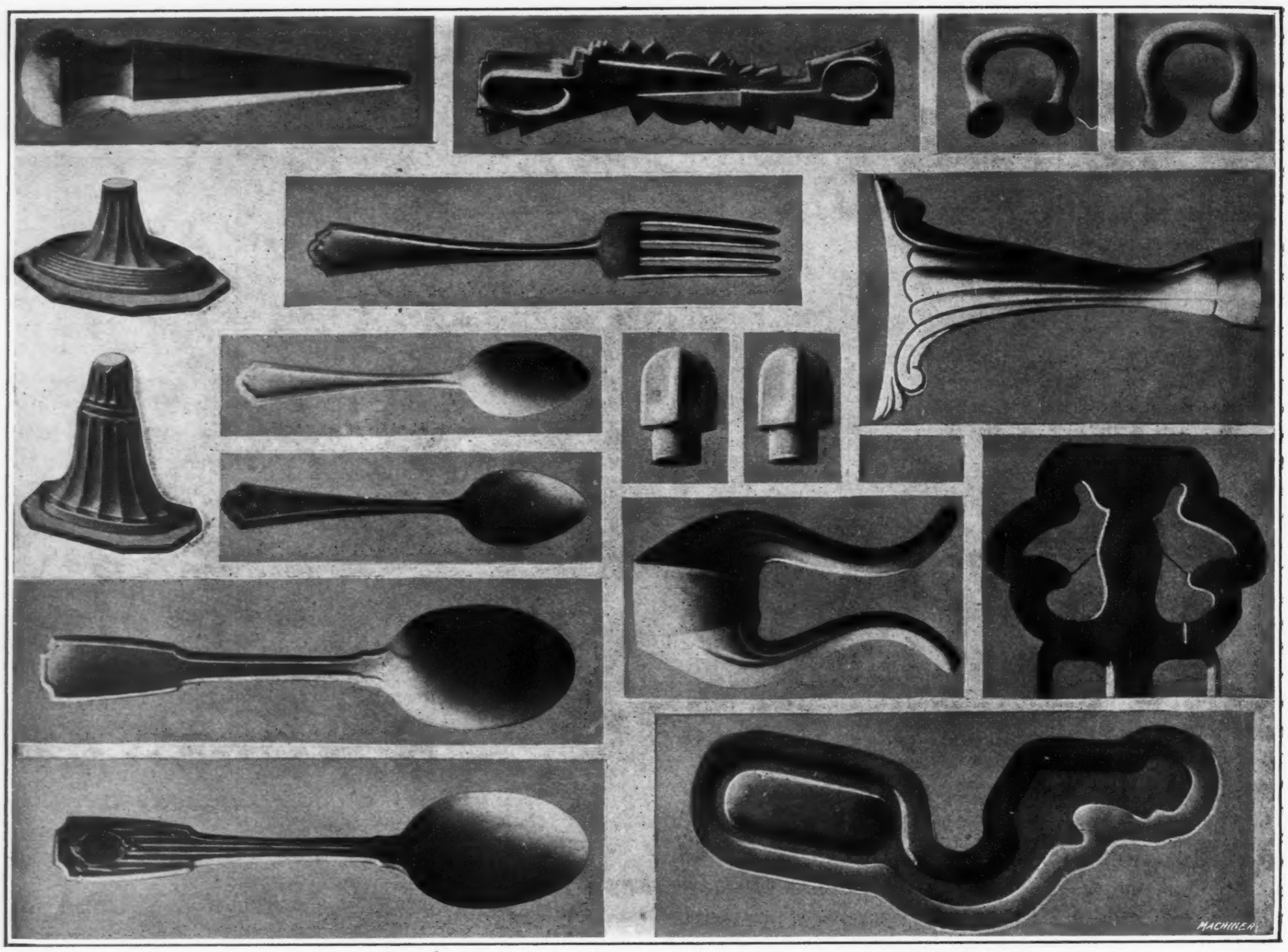



Fig. 7. Collection of Plaster Casts of Dies made on Keller Automatic Profiling Machine

provides the reciprocating motion of the work-table. For this purpose, there is a horizontal shaft *J*, Fig. 2, at the base of the machine, fitted with a pair of friction disks. These are set tight enough to drive, but loose enough to slip readily, after the feed motion for each reversal has been obtained.

When the motor is running in one direction, the friction disks on the shaft *J* rock the link *K* back, and after this has been done the disks slip until the motor is reversed. Then the link *K* is carried forward and the hardened steel pawl carried at the top of the link engages the ratchet on the feed-screw and rotates it the required amount to give the feed that is desired for each reversal of the motor, after which the friction disks on the driving shaft slip until the motor is again reversed. The pawl may be set by means of the screw *L*, Fig. 1, to obtain the required feed motion, the feeds employed ranging from 0.001 to 0.004 inch. A graduated wheel at the end of the feed-screw shows the rate of feed which is being employed. Handwheels *M* and *N* are provided for use in controlling the feed by hand.

### Construction of the Special Reversing Switch

The reversing switch which controls the driving motor is of a special design developed by the Keller Mechanical Engraving Co. The important feature is the provision of pivoted contacts which engage the switch and afford a full contact at all times so that arcing is done away with. Hand operated controlling switches are provided at the right-hand side of the machine, where they are in a convenient position for the operator. A separate motor *O* is provided to drive the cutter; and this motor also drives the tracing point in cases where rotation of the tracer is required. The power is transmitted from the motor by means of an endless rope belt and in order to give the required rotary speed for the cutter, different spindles are provided which have pulleys of the required diameters upon them. These spindles are interchangeable in the bearing box, which can be readily opened for the purpose of substituting a spindle with the required size of pulley.

Two general forms of cutters are used on this machine. For taking the roughing cut, or "hogging out" the stock from the die-blank, different forms of fluted end-mills are employed; and after this preliminary operation has been performed, intermediate and finishing cuts are taken with special cutting tools which are made from drill rod. Different forms of fluted milling cutters are used for taking the roughing cut. The form of cutter generally used is shown in Fig. 3 at *A*, but when the sides of the die are perpendicular the cutter employed is of the form shown at *B*. The tools used for

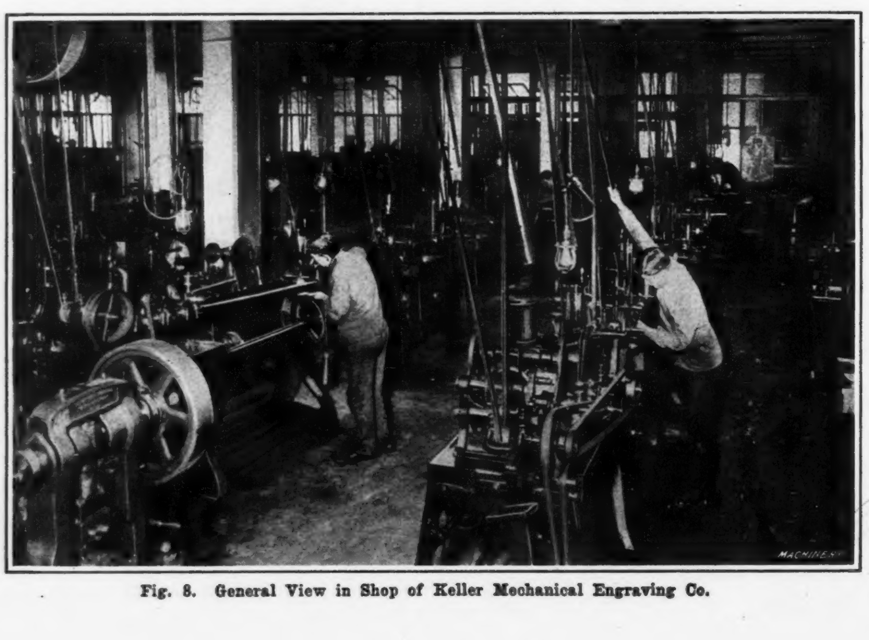



Fig. 8. General View in Shop of Keller Mechanical Engraving Co.

taking the intermediate and finishing cuts are shown at *C* and *D* respectively; and cutters of this character are easily made by grinding them out of a piece of drill rod. In order to get the proper relation between the movement of the tracing point over the pattern, and of the tool which is cutting the die, it is necessary to have the tracing point of exactly the same form as the cutter which is being used. In Fig. 3, suitable tracing points are shown beside their respective cutters. This illustration also gives a good idea of the way in which different speeds of the cutter are obtained by substituting spindles with suitable sized pulleys mounted on them.

The cutters are inexpensive, and owing to the sensitiveness of the machine, they last for an astonishing length of time before they require regrinding. It is important to note that the Keller automatic profiling machine is so designed that the cutter works on both the up and down strokes of the work-table; there is no idle return stroke, and as a result, there is no time when the machine is running that it is not doing useful work. Hence, its productive capacity is correspondingly high. An idea of the rate at which the machine works may be gathered from the fact that a ⅜ inch cutter will take a cut 9/16 inch in depth under a feed of 0.012 inch and a cutting speed of 5 inches per minute. Cutters used on the machine range from ½ to 3/16 inch in diameter.

After the roughing out of the work has been done by the fluted milling cutter, the special cutting tools are employed for taking the intermediate and finishing cuts. Each of these tools has the same taper at its point that there is on the tracer, the limit being 12 degrees. For cutting dies with very steep sides, an angular adjustment has been provided on the machine, which enables the pattern and the work to be set in such a way that the cut taken by the angular side of the tool is at the required angle to the work. This adjustment is only necessary where the sides of the work are required to be at an angle of less than 12 degrees with the perpendicular. In the case of steep sided work of this character when the work is not tilted, it is necessary to revolve the tracer point in order that it may be readily cleared from the pattern. By rotating the tracer, its action upon engaging the side of the work is similar to that of a screw in its nut, and as a result the tracer moves out of the pattern with very little resistance. When the tracer is required to be rotated in this way, it is carried in a special spindle provided with a pulley, and the endless rope drive from the pulley on the cutter spindle is carried up to this pulley to give the required rotation.

### Making a Right-hand Die from a Left-hand Pattern

In some cases it is desirable to be able to make a right-hand die from a left-hand pattern, or *vice versa*. A case in point is shown in Fig. 4, which illustrates the three parts of a die used for pressing a sword grip. The two parts *A* and *B* make the sides of the grip, while part *C* fits into the socket in the die-block for making the lower part of the grip. For the two parts *A* and *B* only a pattern of the right-hand side was made. Then in sinking the two sides of the die from this pattern, one was made direct while the reversing attachment on the machine was used for the other. It has already been explained that the work-table is given a vertical reciprocating motion so that the tracing point passes back and forth over the pattern and causes the cutter to follow a similar path over the work. This motion of the table is obtained from a feed-screw. For use in making a left-hand die from a right-hand pattern, or *vice versa*, the work-table is in two parts, which are engaged by a feed-screw threaded right-hand at one end and left-hand at the other end. It will be evident that the rotation of this screw causes the two halves of the table to have reciprocating motions in opposite directions. Then the movement of the tracer point over the pattern causes the tool to follow the same path but in the opposite direction, so that the work is the reverse of the pattern.

### Method of Setting-up and Operating the Machine

It has already been mentioned that the dies produced on this machine require no preparatory roughing out. In preparing to sink a die, the first step is to set the model up on the work-table. Then the die blank is located in the proper relation to this model by means of a suitable gage, and the fluted milling cutter is set up in the machine. After this has been done, the cutter is allowed to drill into the work to the required depth for the roughing cut, this being limited by the tracer point which engages the pattern when the cutter has reached the required depth. Then the feed motions are started and the cutter is fed over the entire surface of the die for the roughing cut. The hand wheels *M* and *N* are used in operating the machine while taking the roughing cut, as shown in Fig. 5; and the automatic feed for finishing.

After this has been done, suitable engraving tools are substituted in the spindle and the intermediate and finishing cuts are taken, which completes the machine work. The die is then taken to the finishing department, where it is gone over by hand to remove tool marks and clean it up where such treatment is found necessary. Absolute uniformity in the work is assured by this method, there being no chance for errors in the depth of cut or in the outline followed by the tool. The perfection to which this method has been developed is chiefly due to the fact that the Keller Mechanical Engraving Co. does a large business in making dies, and that they used a number of their own machines for this work. Hence, the machines have been built with the users' requirements in view just as much as the machine builders', and all weak points of the design, which could only be discovered through an extensive experience in operating the machines, have been eliminated.

* * *

## HEATING MOTOR TRUCK STEEL TIRES ELECTRICALLY

An ingenious and effective method of heating steel tires for motor truck wheels is employed in the works of the Pierce-Arrow Motor Car Co., Buffalo, N. Y. The wheels are made of ash, and the tires are forced onto the felloes while hot, using a hydraulic press for the purpose. The tires cannot be heated very hot, of course, for if heated to a high temperature the heat would char the wood and spoil the felloes. They are heated to a temperature that just about makes the wood smoke. The heating is accomplished by means of a transformer, the tire to be heated being laid on its side in a sheet steel tub containing the transformer coil. When the current is turned on, the action in the primary coil causes the tire surrounding it to act as a secondary, and the currents traversing the rim heat it quickly and uniformly. The coil is not placed exactly in the center of the tire, being on the contrary, placed near one side but the heat is uniformly distributed. Three minutes only are required to heat a tire about one-half inch thick, ten inches wide and thirty-six inches in diameter to the required temperature. There are several advantages of the practice: the tires are heated quickly and uniformly; there is no danger of fire, an important consideration in a woodworking shop; they are heated without being sooted or oxidized; and the workmen are not subjected to the heat and discomfort incident to working near a large heating furnace of the usual type.

* * *

The United States supplies a large proportion of the gasoline used for motor cars in Germany. Russia and the East Indies also furnish considerable quantities. It is believed that these sources of supply have now been cut off, so that outside of the accumulated stock of motor fuel, the wells in Galicia are the only ones from which motor fuel can be obtained, and these wells can be depended upon for crude oils only in limited quantities. It is reported that at the present time alcohol and benzol are used exclusively by cars in the military service, but the supply of alcohol is also likely to be limited, as the grain, potatoes, etc., from which it is made must be carefully preserved for food purposes. In a machine-made war, such as the present one pre-eminently is, the question of motor fuel is an important item. Germany is a leader in the field of chemical science, and it will be interesting to see if her scientists will be able to solve the problem.

# TURNING TOOL-HOLDERS—2

A STUDY OF LATHE TOOL-HOLDERS USED FOR TURNING, CUTTING-OFF AND SCREW CUTTING

BY JOSEPH HORNER*

THE Johnson tool-holder shown in Fig. 53 is made by the Pratt & Whitney Co. This holds the cutter in a recess at the side, which has beveled shoulders to fit the beveled edges of the cutter. The latter, as seen in the cross-sectional view, is concave on the sides, affording the greatest amount of clearance with the least reduction of area; and on account of the bevel it is necessary to grind the top square for a distance equal to the depth of cut. The clamping is performed chiefly by the tool-post pressure. A knurling tool is sometimes superimposed on the holder, and is pivoted to throw the knurl up out of the way when the cutting-off blade has to be used. The holder manufactured by the Billings & Spencer Co., Hartford, Conn., is made in two parts, as shown in Fig. 54, and united with a couple of screws, the one at the front being quite heavy. The pressure of the tool-post screw is also of assistance in binding the blade with additional firmness. An English style of holder with one clamping bolt is shown in Fig. 55, the blade making a close fit throughout the length of the holder, and being pinched for a distance of about one-third the length by the squeezing-in action of the bolt and elastic end of the holder.

The Western Tool & Mfg. Co., Springfield, Ohio, makes straight and offset holders of the types shown in Fig. 56, embodying the principle of vertical pressure induced by a screw, and transferred to a grooved clamp that forces the cutter downward and firmly into place. A slight amount of backward and forward movement is allowed to permit of variations in the widths of cutter, and to insure a correct wedging action. The offset holder is made right- and left-hand, the one shown being right-hand, that is, when facing the headstock. Fig. 57 illustrates the straight and offset holders made by the Ready Tool Co., in which the beveled-section cutter is secured by a screw on top, and a lateral screw. The metal in the holder is carried forward and downward at the nose to give proper support where it is most needed. The pressure of lateral bolts is also utilized in the Armstrong tool-holders, Fig. 58; in the holder *A*, the screw bears directly against the face of the cutter, and a wedging action by one bolt is employed in more recent designs *B* and *C*. Fig. 59 represents a holder of European design, using the pressure of a bolt head in conjunction with a short beveled clamp which fits angular seatings under the head and in the bottom of the holder groove. The cutter has an enlarged top to increase the side clearance. A clamp pulled in the vertical direction may be noted in the succeeding illustration, Fig. 60, this being an English design. In at least one type of holder, a clamp is passed right across the cutter, and is pulled up by a couple of bolts, see Fig. 61. This is known as the Slate tool-holder, and is also made offset.

Cutting off is an operation that is likely to give some trouble in the breakage of cutters or damage to work, because of the great liability of the tools "digging in." This is induced by either of two causes—one, the tendency of the rest, especially if of weak construction, or loosely fitted, to lean toward the work; the other, the tendency of the work to climb up over the cutting edge. A device that is introduced to prevent these happenings is the addition of a steadyrest to touch the top of the work and prevent it from rising. The Slate holder of this type, Fig. 62, carries an extension to the cutter clamp, and this receives a slotted rest adjusted to suit the diameter of the bar being cut off. Another style, made by F. Burnerd & Co. of Putney, London, England, Fig. 63, has the steadyrest clamped by two bolts which draw clamps against its beveled edges. The cutter is jammed firmly in place by a clamp drawn up by the set-screw. This holder is also found advantageous for cutting square-threaded screws, particularly long ones which would be likely to give trouble. Cutting-off cutters may be mounted in duplicate for cutting out rings to uniform widths. The Mingst holder, Fig. 65, for this class of work has a widened head adapted to receive two blades and one or more spacing blocks to space them apart to an exact distance, the hole and the spacing blocks having tapered sides to keep the beveled cutters upright. A set-screw binds the whole arrangement in place.

### Screw-cutting Holders

Holders for screw-cutting represent a special class, having two requirements that distinguish them. One is the desirability of using a cutter which will preserve its edge profile during repeated sharpenings, the other the need for a swiveling action to twist the nose of the tool so as to make it go into the angle of the thread groove. This is particularly necessary for threads of short pitch, and for deep threads. The swivel action saves special grinding of the cutter nose, and also adapts the cutter for cutting either right- or left-hand threads equally well. A good many of the holders illustrated are suitable for threading, within certain limitations, but none of them embody any special provisions for this class of turning. A distinction which may be noted is whether the holder is of the fixed-top-rake or the fixed-front-rake (clearance) style. The former is not so well adapted for threading purposes because the nose of the cutter has to be ground to shape, and this shape is soon lost in sharpening, whereas a fixed-front-rake cutter may be made of the correct profile and will retain this although ground repeatedly on the top, until the stump is too short to be of use. On the other hand, the shallower depth of a fixed-top-rake cutter is preferable in certain instances where a deeper cutter would foul the sides of the thread groove. Both types are illustrated in the examples following.

A simple holder with fixed-front-rake is shown in Fig. 65. This is made by the Ready Tool Co., and the cutter is of a section ground to suit the thread to be cut, only the top being sharpened. By the addition of serrations and a wedge, the cutter is held rigidly without exerting excessive pressure with the set-screw. The same design of holder is also made in offset style. A heavy tool-holder of English design, Fig. 66, includes a set-screw below for adjusting and maintaining the cutter to the correct height, clamping being effected by tightening the grip of the split nose of the holder. Another style of tool-holder designed on the same principle is also manufactured with a wider opening to receive a chaser including several threads, for finishing. A method of fastening the cutter or chaser, which is adopted in many cases, is to leave it exposed at one side, so that threading may be done up to a shoulder. Sometimes the cutter is formed with an under-cut vee on the inside, matching the side of the holder, and is secured with a clamp bearing against a beveled edge at the back (see Fig. 67). Grinding is done on top, and the chaser can be used as long as there is enough of it left to be gripped firmly in the holder. To prevent risk of slipping, the side of the chaser in some holders is serrated, and the serrations engage with similar ones on the holder.

A popular style of holder includes a fine screw adjustment for the cutter (see Fig. 68). This is a heavy type of straightforward holder. Holders with bent shanks are also made as shown by the dotted lines in the plan view. Different types of cutters are shown in Fig. 69, comprising single-point standard forms *A* and *B* for U. S. standard threads, and Whitworth threads respectively; the one-sided, or "single offset" as it is sometimes called, shown at *C*; and the offset or "double offset" *D* for working up to shoulders. The last-named cutter can be reversed in the holder, to bring the threading point to the right or left. There is a point of interest in connection with the shape of the profile of a cutter for cutting screws on the so-called S. I. system, or metric "Système Internationale." The cutter is different in outline according to whether a screw or a tap is being threaded; if the former, the point appears as at *A*, Fig. 70; if the latter, the point is as shown at *B*. The reason becomes obvious on examining the fit of this

* Address: 45 Sydney Bldgs., Bath, England.

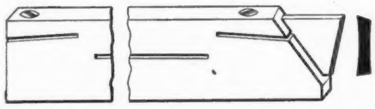


Fig. 53. Johnson Tool-holder for Cutting-off Tool.

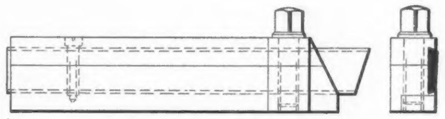


Fig. 54. Billings & Spencer Cutting-off Tool-holder.

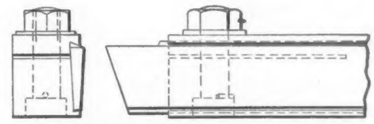


Fig. 55. Split Tool-holder for carrying Cutting-off Tool.

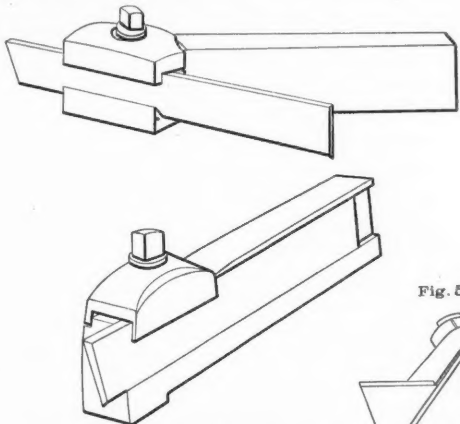


Fig. 56. Western Straight and Offset Cutting-off Tool-holders.

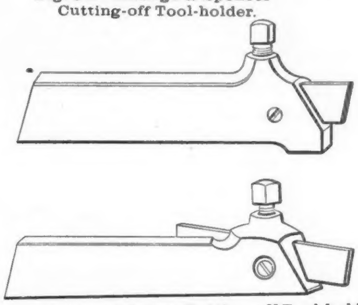


Fig. 57. Straight and Offset Cutting-off Tool-holders made by the Ready Tool Co.

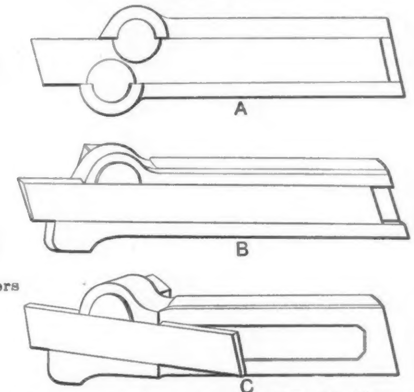


Fig. 58. Armstrong Cutting-off Tool-holders.—A shows an Early Type, and B and C show Modern Straight and Offset Holders.

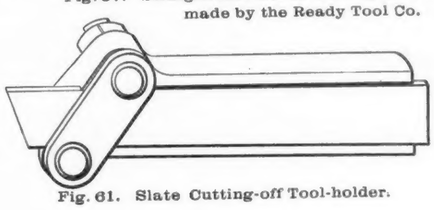


Fig. 61. Slate Cutting-off Tool-holder.

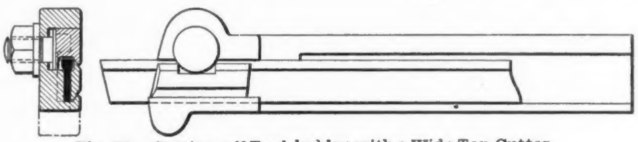


Fig. 59. Cutting-off Tool-holder with a Wide Top Cutter.

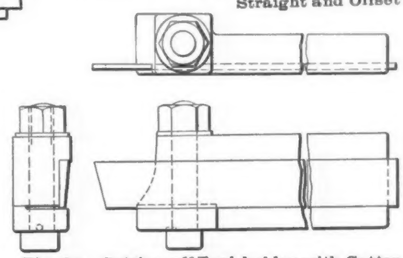


Fig. 60. Cutting-off Tool-holder with Cutter held by Combination Clamp.

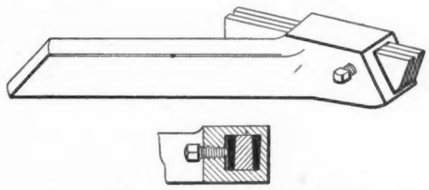


Fig. 64. Mingst Double Cutting-off Tool-holder for Rings.

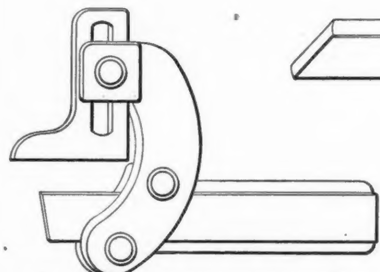


Fig. 62. Slate Cutting-off Tool-holder provided with Steadyrest.

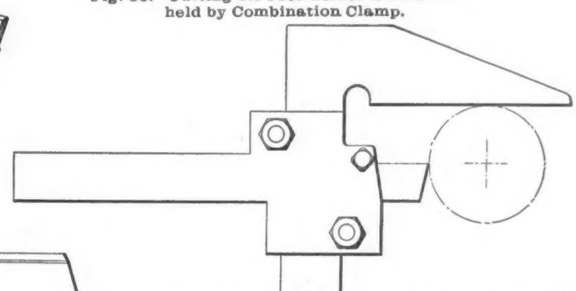


Fig. 63. Another Type of Cutting-off Tool-holder provided with Steadyrest.

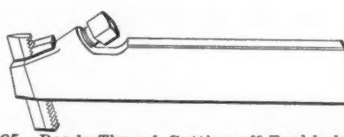


Fig. 65. Ready Thread Cutting-off Tool-holder with Screw and Wedge Clamp for Cutter.

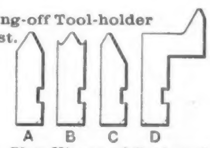


Fig. 69. Plan Views of Cutters for Use in Thread-cutting Tool-holders.

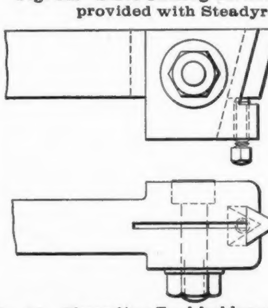


Fig. 66. Threading Tool-holder with Adjusting Screw for Cutter.

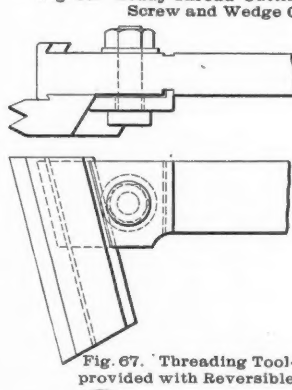


Fig. 67. Threading Tool-holder provided with Reversible Cutter.

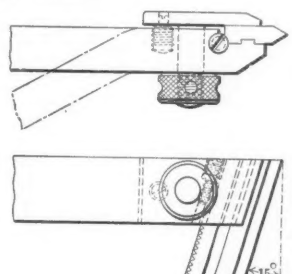


Fig. 68. Threading Tool-holder for Screw for Adjusting Cutter.

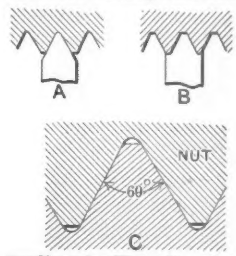


Fig. 70. Profilers for Threading Cutters. A for Screws and B for Taps. The Form of the Thread is shown at C.

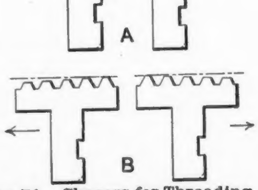


Fig. 71. Chasers for Threading Tool-holder.—A Fine and Coarse Pitches, B Chamfering of Thread for Right and Left-hand Cutting.

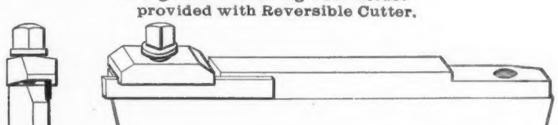


Fig. 72. Rhodes Threading Tool-holder.

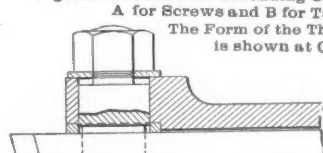


Fig. 73. Tool-holder with Clamp Bolt which permits Cutter to be Twisted.

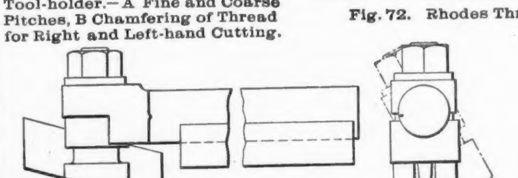


Fig. 74. Smith & Coventry Swivel Tool-holder for Screw Cutting.

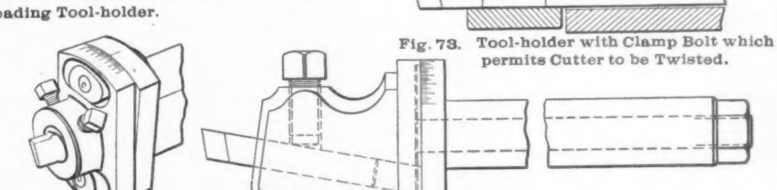


Fig. 75. Screw Cutting Tool-holders with Swivel Heads.

*Machinery*

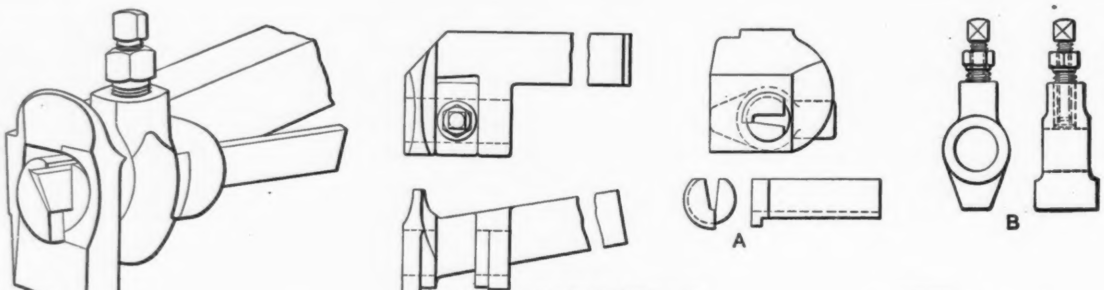



Fig. 76. Taylor Swivel Type of Screw-cutting Tool-holder and its Parts.

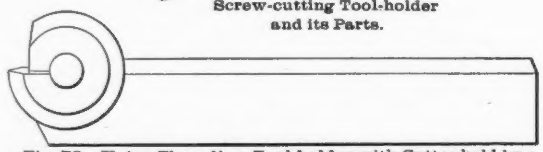


Fig. 78. Union Threading Tool-holder with Cutter held by a Taper Socket in Shank.

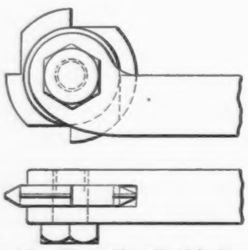


Fig. 77. Threading Tool-holder provided with Disk Cutter.

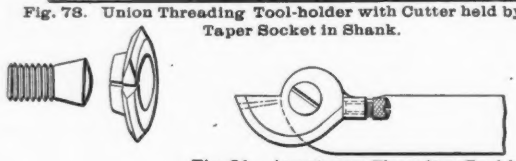


Fig. 81. Armstrong Threading Tool-holder provided with Screw Adjustment.

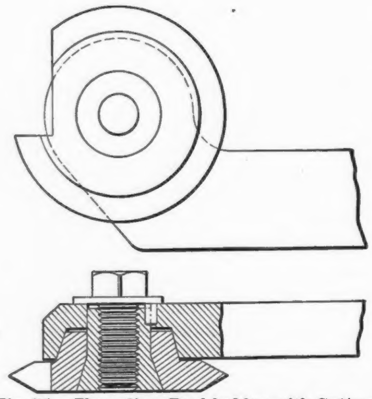


Fig. 79. Threading Tool-holder with Cutter held by Double Friction Clamp.

Fig. 80. Tool-holder with Disk Cutter provided with Means for Adjusting Height of Cutter.

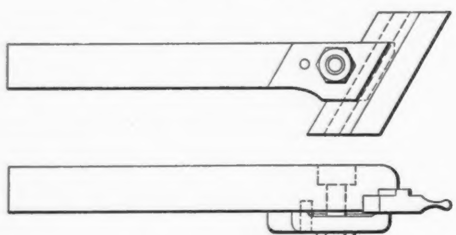


Fig. 83. Tool-holder used for Backing Off Milling Cutters.

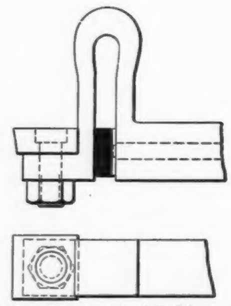


Fig. 84. Spring Tool-holder with Rubber Pad in Gooseneck and End Pressure Rod.

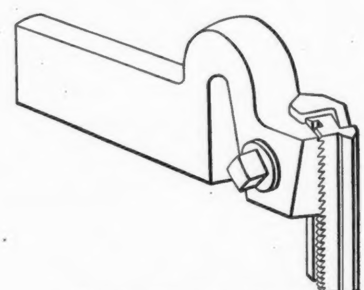


Fig. 82. Western Spring Tool-holder for Threading Operations.

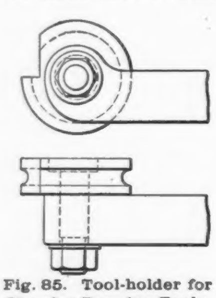


Fig. 85. Tool-holder for Circular Forming Tools.

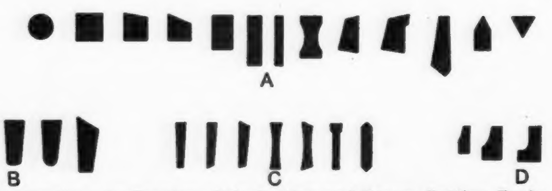



Fig.86. Sections for Turning, Side Cutting and Screw Cutting Tools are shown at A, Deep Sections for Turning, and Similar Operations at B, Special Sections for Cutting-off Tools at C, and Sections for Cutters for Chamfering, etc. at D.

*Machinery*

type of thread, see Fig. 70 at *C*. The bolt has flat thread tops and rounded roots, but a tap to cut the nut threads is the reverse style, *i.e.*, rounded tops and flat roots.

Threading can be done more rapidly with a chaser than with a single-point cutter, and the finer pitches can also be cut at one traverse. The objection to the chaser is that slight differences in pitch are likely to occur between the chaser and the correct pitch of the screw that is required to be cut; hence it is desirable for very accurate work to use a single-pointed tool, or a compromise may be made, roughing out more rapidly with the chaser to a diameter slightly over size and finishing finely with a single-point cutter. Two examples of fine and coarse pitch chasers are illustrated in Fig. 71 at *A*. It is best to chamfer the chasers off as illustrated at *B*, for right- and left-hand threads, respectively. The first point only takes a very shallow cut, and the succeeding ones gradually deepening cuts until the complete form is finished by the last tooth. Another use for holders of this kind is to receive cutters for special operations, as chamfering, rounding, and profile turning; the blanks are prepared to the same outline as those for ordinary threading operations, but the faces are milled to the desired profile, and as sharpening is done only on the top the profile remains unaltered during the life of the tool. The Rhodes square-threading tool-holder, made by the Pratt & Whitney Co., is of the type without top rake, and uses a cutter ground with suitable side clearance, and held by a strap and set-screw, Fig. 72. The strap has an elongated hole and adjusts itself to varying widths of cutters. Right-hand threads are cut with the cutter placed at one end of the bar, and left-hand when it is transferred to the other end. A narrower roughing cutter is sometimes employed to rough out the thread preparatory to completing it with one of full width.

Some of the holders illustrated earlier in these articles possess an axial swiveling motion which is very useful for tilting a thread-cutting tool, and there are also some holders especially intended for screw-cutting, which also have this feature. An example is shown in Fig. 73, utilizing a round-section cutter passing into a hole in the shank, and gripped by a drilled bolt which pulls it up against a collar. The Smith & Coventry holder previously illustrated is also built with a cylindrical shank, Fig. 74, to rest in a concave block on the slide-rest, and so be swiveled at any angle for right- or left-hand square threads. Fig. 75 shows two other English designs of threading tool-holders with swivel heads, one of which is locked by a bolt passing through the shank, the second by two bolts sunk flush with the swivel plate. Messrs. Charles Taylor, Ltd., of Birmingham, England, have for many

years past manufactured a swivel holder, Fig. 76, carrying a cutter of vee-section pressed down into a socket or barrel *A* by the small inner screw in the loop-piece *B;* the latter binds the barrel in the holes in the holder when the larger hollow screw is tightened, and the angle of the barrel may, of course, be varied according to the amount of swivel of the tool point demanded by the thread angle. As the cutter is only locked by the inner set-screw, it can be removed for sharpening or substitution without altering the angle at which the barrel is set. The perspective view shows the appearance of the assembled holder.

The idea of using a permanent section of cutter which will remain unaffected by repeated sharpenings is very attractive, as may be noted from the examples of fixed-front-rake (clearance) screw-cutting holders already shown. Another device, not adopted to the same extent, is that of embodying the section in a circular or partly circular cutter, which is revolved as metal is removed by grinding. This gives a compact tool that is easily produced and very stiff and strong. The simplest way to attach the disk to the holder is to draw it against the side of the latter with a bolt or set-screw, a method open to the objection that very hard tightening is required to insure freedom from slipping under the cut. A greater degree of frictional grip may be obtained in the manner seen in Fig. 77, by pulling the sides of the holder against the disk. The latter, it will be observed, is notched out in four places, giving the choice of more than one edge to apply to the work that is to be threaded. This is convenient for three reasons; it provides a reserve of edges in case of breakage, it also gives a reserve to obviate the need for stopping to sharpen a dulled edge, and it offers the choice of one edge for roughing and another for finishing. Such a holder cannot work close up to a shoulder; hence there are several holders with the disk located on the side, and an improved means of binding with the exercise of but moderate power on the screw. One such is shown in Fig. 78, which is made by the Union Caliper Co., having a tapered boss on the cutter, and the latter split through in order that the action of tightening the bolt may expand the cutter firmly into the hole in the shank. Another design incorporating a taper fit, illustrated by Fig. 79, is manufactured by the Machine Tool Attachment Co., of Manchester, England. The disk is solid and is drawn in by the set-screw fitting in a bushing with tapered head. As this bushing is prevented from rotating by a plug, the effect is to enhance the frictional hold, securing the cutter inside and outside.

Another solution of the problem of securing a circular cutter is shown in Fig. 80. This is rather an old idea which was originally evolved for general turning. The pin on which the disk is held is so placed that the pushing forward of the plunger rod by the screw at the rear has the effect of raising the cutting edge. The other two holes are used subsequently after frequent sharpening has carried the edge a considerable way around the circumference. The Armstrong threading holder illustrated by Fig. 81 utilizes specially shaped cutters backed off behind the edge, and adjusted through the medium of the small stop-screw, after which the nut on the end of the pivot bolt is tightened. The dotted lines indicate the radial course of future grindings. Multiple-threaded cutters or chasers, on the same principle as those shown previously in Fig. 71, are also made in the circular form and bolted to the side of a shank. Spring threading tool-holders are preferred in many shops, and some types of these incorporate one or the other of the methods already shown of holding cutters, together with a gooseneck shank. Fig. 82 is an instance, this tool being made by the Western Tool & Mfg. Co., Springfield, Ohio. Just sufficient spring is afforded to prevent chatter while cutting the thread.

### Forming Tool Holders

Forming, when it has to be done in an ordinary lathe, may be accomplished with cutters held in some of the holders already shown, the chief limitation soon reached being that of width. But certain designs, shown in Figs. 47 and 48 for example, will carry forming tools of generous width. Relieving lathes require a considerable variety of shapes to suit various profiles of milling cutters, and a useful holder for this class of service is that represented by Fig. 83, which is made on a similar plan to threading holders previously shown, and receiving blanks with standard bodies. The cutter shown is a narrow delicate one, but the holder is equally capable of carrying a width of working edge equal to two or three times the width of the shank. Spring holders for plain turning, or for forming are employed to a limited extent, and one form is shown in Fig. 84. This has a rubber pad adjusted by a screw to regulate the amount of elasticity. Circular profiling cutters, similar to those employed on the cross-slides of turret lathes, are often used for ordinary lathe service, and a typical design is that utilizing a simple bolt fastening, Fig. 85, to draw the cutter against the side of the shank.

It has already been mentioned that the various cross-sections of tool steel that are used for making the cutters for tool-holders can now be bought in the open market. Fig. 86 shows a variety of these sections, together with a note concerning their particular functions. While all these sections are in common use, there are, of course, special sections which must be forged to shape. These are not illustrated for the reason that they are not standard forms obtainable in the open market; and such special sections for handling a single class of work are of little interest to those who have not had occasion to use them.

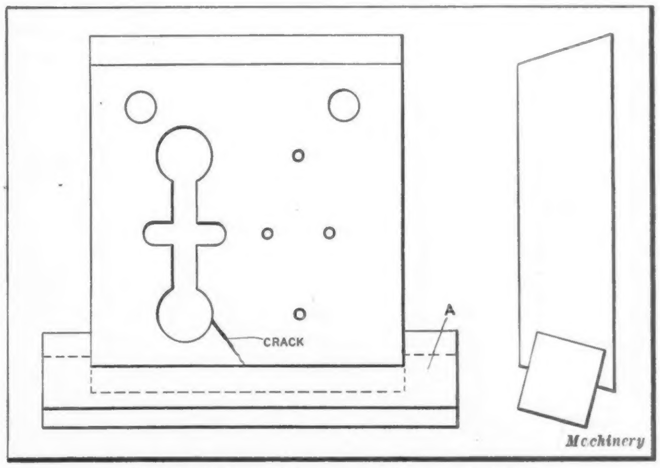
* * *

## REPAIRING CRACKED DIES

BY ROBERT J. ALBRECHT*

Even where the greatest care is taken, blanking dies will occasionally be cracked in hardening. When the crack is parallel with the angular sides of the die, the binding screws in the die-block will close up the crack; but when the crack is at right angles to the angular sides, it is much more difficult to make the die fit for use. In some shops it is the practice to grind the sides of the cracked die square and at right angles to the top, after which the die is inserted in a solid shoe. While this method gives fairly satisfactory results, it adds considerably to the original cost of the die.

The accompanying illustration shows a cheap method of repairing a cracked die known as the "hot patch" method. For this purpose a piece of machine steel of suitable size has a slot milled in it to one-half its depth, the width of the slot being about 0.010 inch to the inch less than the length of the cracked die-block. This piece of steel is heated to a dull red heat, and the die-block is placed in a vise in such a way that the crank will be closed up tight. The heated clamp is then



"Hot Patch" Method of repairing Cracked Die

taken from the furnace and slipped over the die as shown at *A* in the illustration. When the clamp cools, it will contract and secure a very tight grip on the die, which will be quite adequate to keep the crack closed. It is important to note that the cooling of the clamp should be hastened by dropping a little water on it, and as soon as the clamp has secured a preliminary grip on the die, the die and clamp are removed from the vise and quenched in water to prevent the hot iron from drawing the temper of the die.

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# SNAPSHOTS ON THE ROAD

ECONOMY OF SODA ASH VS. SODA—ETCHING FIRM NAMES ON PRODUCT—BRAZING HIGH-SPEED STEEL TIP TO CARBON STEEL SHANKS—SAVING TIME ON SLOTTING NUTS—BURNHAM'S "WRITE-UP"

THE field service men run across many time and money-saving ideas in the shop, and some of them are not purely mechanical at that. For instance, one of the large automobile manufacturers of the Middle West turned an engineer loose in its factory to see what he could find in the way of leakage and how it could be stopped. Some of the places where there was found a chance to save money were rather surprising. One of them was at the top of the soda tank where the oil accumulated from dipping work for cleaning. It had been customary to skim the oil from the top of the tank from time to time and throw it away. The object was to keep a clean surface on the soda tank, and it was not thought that the oil accumulated was worth saving. When the engineer discovered this fact, the skimmings were ordered saved and the oil cleansed, thereby effecting a saving of several dollars a year.

—"that little suggestion you have just made is worth all the information I have given you in the last half hour"

Another more important leakage discovered and incidentally one that may be found in almost any shop of any size, was in the use of soda. The matter was very simple. One day he saw a box of soda ash in the shop and not being very familiar with the different forms of soda he investigated and found that soda ash was merely common soda with the "water of crystallization" driven off. Following this investigation, it was found that all the soda used in the factory was commercial soda, which cost approximately eighty cents per hundred pounds; soda ash cost about a dollar per hundred pounds. Less soda ash than commercial soda was required for a soda solution and the results obtained were identical.

"Of course," said the engineer, "you see that soda ash costs us slightly more per hundred pounds than the commercial soda, but then, we don't have to pay for all the water we used to use and we are saving several hundred dollars a year on this item alone. So there you are."

### Etching Firm Names on Product

"Say," said the shop superintendent, "that little suggestion you have just made is worth all the information I have given you in the last half hour."

The field service editor had been looking around the shop for a half hour getting a few pointers for his journal and incidentally listening to the description of kinks that every live shop man has up his sleeve. And then, when going through the assembling department, the superintendent lamented because the marking of the firm name on the finished product looked so poorly. This condition was due to the unevenness of the stamping, particularly in regard to the depth of the letters. After hardening, the surface grinding operation accentuated the trouble, and the result was a very ragged looking firm name marked on the finished product.

The field service man suggested etching, but this to the shop man had always been considered a very slow method, and one only to be used in emergencies. In a few minutes time, however, he was shown how by using an inexpensive engraving machine on the market, he could with a few changes, cut the desired letters in a wax coating on the product and then etch the legend quickly and neatly. The result leaves little to be desired.

It was just another case of reciprocation in the exchange of shop ideas—and it proved to be a half hour well spent for both parties.

### Brazing High-speed Steel Tips to Low-carbon Steel Shanks

There is a user of heavy planers in New England who has cut his high-speed steel tool bill materially by using planer tools with low-carbon steel shanks and high-speed steel tips brazed thereon. A heavy planer tool, say 1¾ by 2½ inches in cross-section, represents a number of dollars on the high-speed steel tool bill, but the same number of pounds of low-carbon steel adds but little more to the total cost of the tool.

But it took him some time to discover a good method of holding the tip to the tool shank. He now accomplishes it by brazing, and the little kink is in the method of applying the flux and spelter. Anyone who has done brazing realizes that it is "some job" to control the flux and the spelter while the two pieces to be joined are at the brazing heat.

This manufacturer uses a foreign welding preparation composed of flux and the spelter pressed into sheet form. The sheet is scored with grooves, dividing it into small diamond shape sections. The workman breaks off a piece of the right size and inserts it between the tool bit and the shank when they have been heated to brazing temperature, and then presses them firmly together. Thus the flux and spelter are applied just where he wants them and at just the right time. For brazing, this little tablet is "meat and drink in one."

"For brazing, this little tablet is 'meat and drink in one'"

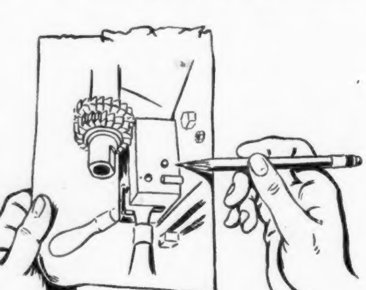
### Saving Time on Slotting Nuts

"Sure you may go out in the shop and see if you can find anything of interest for your paper," said the superintendent.

The field service man started off, but just as he was leaving the superintendent's office, he was halted with, "And if you see any place where we can increase production or improve our methods, be sure and tell us about it because we are not thin-skinned around here; we like to know of all the points that will help us."

The first thing that the editor saw after he entered the shop was a couple of boys running hand milling machines and slotting nuts. The vise jaws were cut away so as to hold the nuts at an angle, and after each cut the boy unscrewed the vice, turned the nut and repeated the milling operation. Ninety-nine per cent of the time was spent in turning the handle of the vice.

The field service man secured his material, and when he went back to the office, told the superintendent of the hand milling job and supplimented it with a description of a little jig that is shown in the illustration. The advantage of this jig is that it is loaded and operated entirely by one hand, while the milling machine table is operated with the other hand.



"The advantage of this jig is that it is operated and loaded entirely by one hand, while the milling machine table is operated with the other hand"

"Say, that looks good to me," said the superintendent,

"and I'm going to make one right away. Come in again when you're in town. We like to have visitors like you—it pays!"

### Burnham's "Write-Up"

Once in a while we run across a manufacturer of the old school who thinks the chief function of a technical journal is to publish "puffs" and "write-ups." These fellows generally are proprietors of shops so far behind the times that none of their working methods would look well in print.

One of these fellows of the old school runs a shop in a city not far from New York. When interviewed, he thought it would be a fine idea to have an "article" written about his factory, and after some deliberation he turned around with the remark, "Can you take shorthand?" The visiting editor replied that he regretted that he could not take shorthand, but he was a fairly rapid writer. This did not seem to satisfy the shop owner, and he reached over for a slip of paper and wrote the following "article"—just as we have reproduced it:

"Can you take shorthand?"

> "Oscar Burnham of ——, N. J., has a very interesting factory. He is a manufacturer of plumbers' tools and metal specialties. Started in business in 1876. He makes a specialty of tinners' torches for all the trade. The goods are made for gasoline, kerosene, alcohol, electricity, natural gas, crude oil, etc. In this factory can be seen casting, machining, soldering, brazing, stamping, drawing, etc."

It took a little argument to convince Mr. Burnham that this was not the kind of an article that MACHINERY cared to publish, and he reluctantly consented to take the visitor through the shop. Fortunately, or unfortunately for MACHINERY'S readers, the shop was so uninteresting and so far behind the times that no space could be devoted to any of the work or methods.

* * *

## HOW WE CAME TO HAVE THE MICROMETER CALIPER

BY W. D. FORBES*

L. D. Burlingame contributed an interesting and valuable article on the origin of the micrometer caliper in the June number. It assembled in convenient form, that which has heretofore been scattered knowledge. I believe that which follows will be of interest to MACHINERY'S readers when read in connection with Mr. Burlingame's article.

In 1887 I was doing some special work for A. C. Hobbs, Superintendent of the Union Metalic Cartridge Co., Bridgeport, Conn. Mr. Hobbs was famous as a lock picker, having gained the prize offered in England to anyone who could pick the lock made by the Bramah Co. in a given time. He also opened the vaults of the Scottish Bank in Edinburgh, but he never picked the lock of the Bank of England, as commonly reported.

I was in Mr. Hobbs' private office comparing some punches with him, using a 1-inch Brown & Sharpe micrometer for the purpose, when A. D. Laws came into the office. He was, at the time, I think, connected with E. P. Bullard in the manufacture of lathes. Mr. Laws was followed into the office by S. Wilmot, who with a Mr. Hobbs (no relation of A. C. Hobbs I believe) was rolling sheet metal by a new process invented by Mr. Wilmot. Seeing the micrometer in my hand, Mr. Laws put his hand into his pocket and drew forth a micrometer and extending it, he shook it at me and said; "There's the first micrometer ever made." Mr. Wilmot immediately pulled a counterpart of Laws' micrometer out of his pocket and then Mr. Hobbs cried out, "Hold on," and opening a drawer in his desk he fished out a third micrometer. Mr. Laws' name was stamped on the frame of his micrometer. Mr. Laws and I had been employed at the same time by the Eaton, Cole & Burnham Co. in Bridgeport, my position there being superintendent, and very often in sport, I had stolen the micrometer, always to be found out and abused by Mr. Laws in his peculiarly fantastic language, the style of which was never paralleled, as those who knew him, will agree.

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Mr. Wilmot then told something of the history of the micrometer. He said that he and Mr. Hobbs had disagreed over the gage of a lot of brass supplied by the Bridgeport Brass Co., where Mr. Wilmot was Superintendent, and both got pretty warm discussing the matter. Mr. Hobbs finally said that there ought to be a better way of determining the thickness of sheet metal than by using a slot in a piece of steel. Mr. Wilmot said; "Yes, and I will make something that will do it, and tell us what is the percentage above and below any nominal thickness asked for." Mr. Hobbs replied: "If you can, you will save the world a lot of trouble." Mr. Wilmot then stated that he had seen in the plant of R. Hoe & Co., New York City, some years before, a measuring machine that had given him the idea of the micrometer now before us. He made a sketch and showed it to Mr. Laws, who gave it to Hiram Driggs to make. Six micrometers were made by Driggs from the sketch.

Mr. Laws always insisted that he had specified forty threads to the inch for this tool and twenty-five graduations on the thimble and Mr. Wilmot claimed the same suggestion. I never knew a better toolmaker than A. D. Laws, and I knew his bent of mind thoroughly. I am sure he never could, and never would have thought that $40 \times 25 = 1000$—that was not in his line. I was told by Mr. Driggs that Mr. Laws wanted the screw cut and the barrel divided so as to read to sixty-fourths inch and finer. Knowing Mr. Laws as I did, I believe the statement true.

Of the six micrometers made, four can be accounted for as being in the possession of the persons named in the foregoing. Where the others went, I have tried in vain to find out. I understand that W. F. Durfee had one and that Isaac Holden was at one time in possession of the other. It may be possible that some of your old subscribers in Bridgeport could tell us where these tools are.

Mr. Wilmot showed me a key-ring which Mr. Driggs had made for him and which, with the measuring instrument seen in the Hoe plant, gave him the idea of the micrometer. The key-ring was of the wire link type with a piece of tubing provided to close the gap on one side where the keys were inserted. A light spiral spring inserted in the tube held it in position. Mr. Wilmot's first idea was to graduate the part of the ring over which the tube slipped, and to insert the metal to be measured between the abutment and the end of the tube, making the spring produce the required contact. But this did not give fine enough measurements, and in talking the matter over with Mr. Laws, he suggested using a thread instead of a spring, and graduating the tube, as was done later on the micrometer. Mr. Driggs suggested dividing the other parallel side of the key-ring micrometer into tenths, enlarging the end of the tube to a disk and dividing this in order to obtain larger and more visible divisions. A central or revolution line, of course, was required on the coarser division side.

But the Brown & Sharpe Mfg. Co. undoubtedly gave to the world this most valuable measuring instrument, no matter whether it originated in France or in Bridgeport, Conn.

* * *

Experiments undertaken to determine the hardening quality of various oils used for quenching baths indicate that mineral oils are superior to cotton-seed and fish oils in their hardening effect. If the hardening effect of water is assumed to be 1, the hardening effect of mineral oils varies from 0.16 to 0.24, while the hardening effect of cotton-seed oil seldom exceeds 0.16, or of fish oil, 0.15. Rosin has a hardening effect of from about 0.13 to 0.14.

# PROVIDING FOR UP-KEEP IN DESIGNING JIGS AND FIXTURES*

## THE INCORPORATION OF FEATURES WHICH REDUCE THE COST OF MAINTAINANCE OF TOOLS

BY ALBERT A. DOWD†

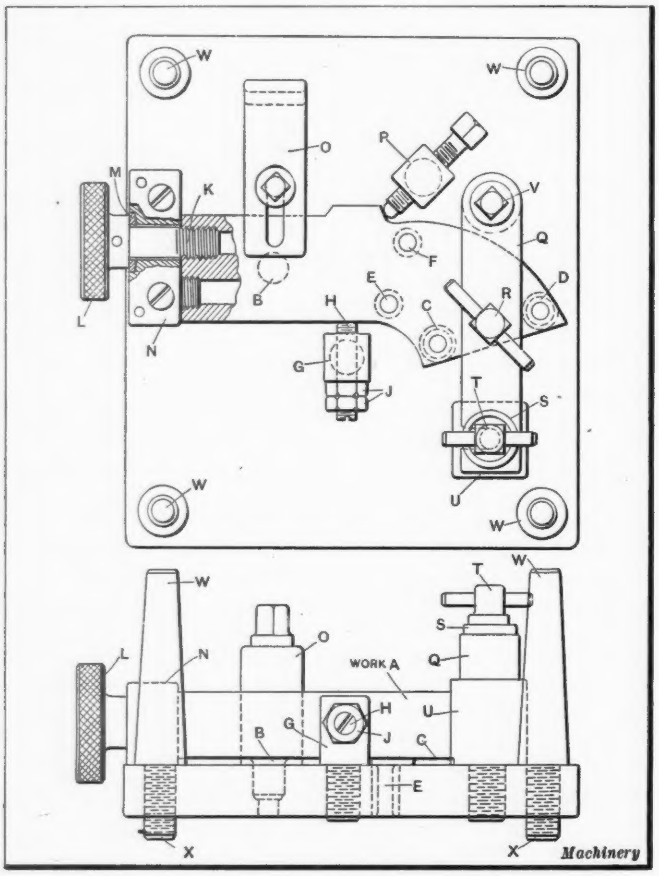


Fig. 1. Jig used for drilling Receiver of Air Rifle

THE importance of providing for up-keep in the design of every sort of fixture used in manufacturing work cannot be over-emphasized, and the designer should not fail to take precautions which will cover this point. In many cases provision for up-keep can be incorporated in the design without increasing the first cost of the fixture to any great extent, while in other instances considerably extra outlay may be necessary. Much depends upon the accuracy required in the finished product and the number of pieces which are to be machined. For example: In gun work, when great quantities of parts are to be produced, no expense is spared in making the fixtures in as durable a manner as possible, and in making provision for the replacement of worn locating points, surfaces, or the like. On machine tool work, however, discretion must be exercised, so that the expense of fixtures may be consistent with the required rate of production and accuracy of the work.

Many factors influence design in this regard. The size and general character of the work determine the type of machinc on which the fixture is to be used, and, therefore, the need for stability and strength. The number of pieces to be machined is a factor which must be considered, for it is apparent that a small number does not require any special care to be taken in regard to the matter of up-keep while a large number may possibly need several fixtures in order to produce the necessary amount of work. In drill jig work, the locating points, bushings, and feet may be made so that they can be readily replaced when abuse or wear of these parts tends to cause imperfect work. The probable necessity for replacements is naturally determined by the rate of production that is required. Another condition which is especially prevalent in drill jig work is the abuse which this class of tool frequently receives. If of too light a construction, the rough handling to which these tools are subjected is often the cause of breakage, and it will be found of advantage to make sure the amount of metal in the jig is sufficient to ensure freedom from breakage in the event of careless handling. Milling fixtures are frequently required to stand very heavy cutting so that great rigidity is an important feature in their construction.

In the case of horizontal turret lathe fixtures or others which revolve about a fixed center, it may frequently be found desirable to make locating rings, points, or surfaces in such a way that adjustment can conveniently be made about this center. A few noteworthy points of construction are given herewith. First:—Location of the work. This is of primary importance and the various fixed points provided in the fixture should be made in such a way that they can either be readily replaced or adjusted, according to circumstances. Second:—The number of pieces to be machined should receive proper consideration in the design, both in regard to cost of the fixture and in regard to probable necessity of replacements. Third:—Weight and rigidity of the fixture. This point is naturally somewhat dependent on the class of work for which it is intended, and the convenience of handling. Fourth:—Gibs. In the case of indexing or sliding fixtures, suitable provision should be made for adjustment by means of gibs or straps, in order that natural wear may be taken up. Fifth:—Cutting lubricant used. This seems a small point to consider in regard to up-keep, but a considerable difference will be found in the life of a fixture used with soda water or some kindred cooling compound, and one on which mineral lard oil is used. A drill jig used for a large number of pieces, and having cast iron feet, will be found to suffer considerably in accuracy when the soda water compound is used for drilling. Hardened steel feet should be used in cases of this kind. Sixth:—Revolving fixtures. Fixtures which revolve about a fixed center, if subjected to hard usage or used for a great number of pieces, may be advantageously provided with means of adjustment about the center of revolution. This is a refinement that is very infrequently

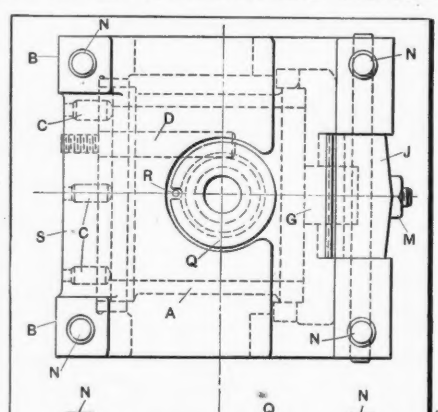


Fig. 2. Jig with Interchangeable Bushings for Different Tools used in machining Cylindrical Part A

* For additional information on the design of jigs and fixtures published in MACHINERY see the following articles by Albert A. Dowd: "The Floating Principle as Applied to Fixture Work," May, 1915; "Machining Irregular Contours," March, 1915; "Compensating and Quick-acting Clamping Devices," January, 1915; "The Influence of Chips on the Design of Tools and Fixtures," October, 1914; "Methods of Holding and Machining Thin Work," August, 1914; "Counterbalanced Indexing Fixtures," April, 1914. See also the following articles: "Clamping Work in Jigs," December, 1913; "Economy in Tool Design," by E. H. Pratt, September, 1913; "Some Jig and Fixture Designs," by Franklin D. Jones, January, 1911; "Improved Method of Dimensioning Jigs and Fixtures," October, 1910; "Pertinent Points in Jig and Fixture Design," by C. Nosrac, August, 1910; "Standard Designs of Jigs and Fixtures for the Manufacture of Small Interchangeable Parts," by F. P. Crosby, published in two parts in July and August, 1909; "Proper Designing of Milling and Drilling Fixtures and Jigs," by R. B. Little, May, 1909; and "Jigs and Fixtures," by Einar Morin, published in thirteen parts from April, 1908, to April, 1909, inclusive.

† Address: 221 Grove St., Bridgeport, Conn.

used, and it is not necessary in the majority of cases unless extreme accuracy is required. There are few points in construction which are applicable principally to individual cases. These will be noted in due course, in subsequent paragraphs of this article.

### Drill Jig for an Air Rifle Receiver Forging

The work *A* shown in Fig. 1 has been previously faced, milled and bored, and tapped at the end *K*, leaving four holes *C*, *D*, *E* and *F* to be drilled on the jig shown in the illustration. This type of jig is "built up" entirely from steel parts, a rectangular plate forming the base of the jig. The work is laid down on the hardened pin *B* and the heads of the two jig bushings *C* and *D* which are ground to a uniform surface. The threaded plug at *K* is provided with a knurled head *L* and draws the end of the receiver up against the steel block *N* which is screwed and doweled to the jig base. A thrust washer is provided at *M* and a slight float is allowed between the block and the plug. The stud *G* is screwed into the plate and the set screw *H* running through it forms an adjustable stop for the side of the receiver, check nuts being provided at *J*. After the work has been drawn up by the threaded plug at *K*, the set-screw in the stud *P* is used to push the work over against the point *H*.

The steel clamp *O* is slid into position and tightened, and the set-screw *R* in the swinging clamp *Q* at the other end of the work is brought to bear at that point. The clamp *Q* is pivoted at *V*, and slotted at the other end where it is locked by an application of the screw and washer *T* and *S*, a steel stud *U* acting as a support for this end. The four legs of the jig *W* are made or hardened steel, screwed into the plate and protruding through the other side to act as a rest when placing the work in position. It will be noted in the construction of this jig that all parts are easily replaceable or adjustable for wear, and that although the jig is somewhat expensive in first cost, the provision for up-keep is excellent. It is obvious that drilling is done *against* the clamps, so that these must necessarily be made somewhat heavier than would be necessary if they were simply required for holding the work.

### Drilling and Reaming Jig for an Electrical Casting

The work *A* shown in Fig. 2 is part of an electrical machine, and has been previously turned and faced. It is required for this operation that the work be located by the previously turned and faced surfaces. The jig body in this instance is made of cast iron and is of box section, as shown at *S* in the illustration; it is bored out to receive the two hardened and ground locating rings *E* and *F*. There are three pins *C* 120 degrees apart, which act as stops for the

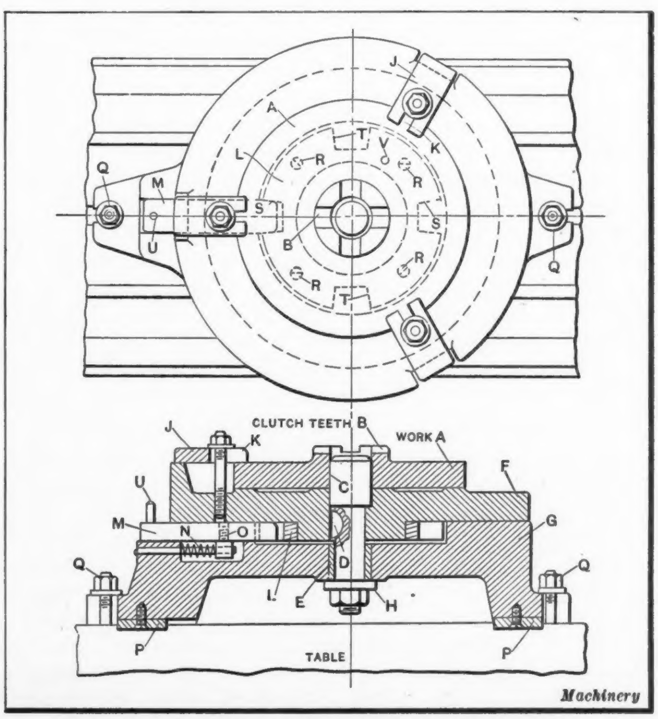


Fig. 3. Indexing Fixture used for milling Teeth in Clutch Gear

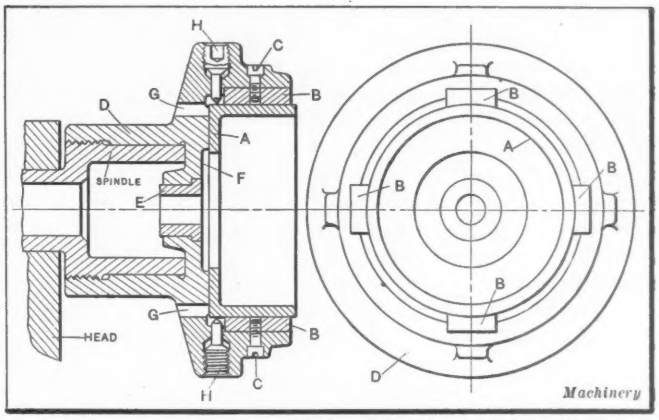


Fig. 4. Fixture provided with Interchangeable Jaws for holding Different Sizes of Work

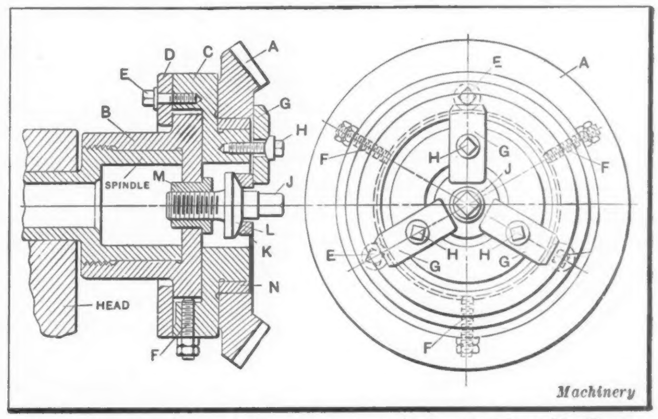


Fig. 5. Ring Bevel Gear holding Fixture provided with Adjustable Clamps

end of the casting, the ends of the pins being rounded so that dirt or chips cannot find lodgement thereon and cause faulty locating. The pin *D* simply acts as a stop for locating the internal bosses on the work; and feet are provided at *B* so that jig casting can be set up on this end for loading purposes. A swinging clamp *J* is provided at the open end of the jig, and this clamp is provided with a rocker *G* which pivots on the pin *H*, slot *K* being cut for its reception.

A swinging clamp-screw is located at *L*, which works in the slot on the end of the clamp *J*, the nut and washer at *M* being used to draw it up firmly. It will be seen that an equalizing action is obtained in this manner on the swivel *H*, so that pressure is equally distributed on the end of the casting. As it was necessary during the machining of this piece to use several sizes of tools and to work from both sides of the casting, it was found advisable to use liner bushings *P* in order to prevent undue wear. These bushings are hardened and ground, and forced into position; and the slip bushings *Q* are slotted to receive the pin *R* to prevent them from turning. The steel studs *N* and *O* on opposite sides of the jig body are ground to a uniform surface and act as feet for the jig. In connection with this jig it is well to note that all parts subject to wear are readily replaceable, thus making the life of the jig almost indefinite.

### Indexing Fixture for a Clutch Gear

In every kind of indexing mechanism one of the chief points in design is to prevent variations in the spacing due to wear on the mechanism. The fixture shown in Fig. 3 is of a type which the writer has used in a number of instances and which is so arranged that wear on the indexing points is automatically taken up by the construction of the device, so that the provision made for its up-keep is excellent. In addition to this feature, the design is not very expensive and it may be made up at much less cost than many other kinds of indexing devices. The work *A* is a clutch gear, the clutch portion *B* of which is to be machined in this setting. As the work has been previously machined all over, it is necessary to work from the finished surfaces.

The body of the fixture *G* is of cast iron and it is provided with two machine steel keys at *P;* these keys locate the fixture on the table by means of the T-slots, and the hold-

down bolts *Q* lock it securely in position. The revolving portion of the fixture *F* is also of cast iron and gets a bearing all around on the base, while the central stud *C* is used as a locator for the work at its upper end, and holds the revolving portion down firmly by means of the nut and collar at *H*. The fitting at this point is such that the fixture may be revolved readily and yet is not free enough so that there is any lost motion. A liner bushing of hardened steel is ground to a nice fit on the central stud at *E* and will wear almost indefinitely, while an indexing ring *L* is forced onto the revolving portion *F* of the fixture, and doweled in its correct position by the pin *V* and held in place by the four screws *R*. The work is held down firmly on the revolving portion by means of the three clamps *J*, these being slotted at *K* to facilitate rapid removal.

A steel index bolt *M* of rectangular section is carefully fitted to the slot in the body of the fixture, and beveled at its inner end *S* so that it enters the angular slots *S* and *T* of the index ring. It will be noted that clearance is allowed between the end of the bolt and the bottom of these slots so that wear is automatically taken care of. A stud *O* is screwed into the under side of the index bolt and a stiff coiled spring at *N* keeps the bolt firmly in position. The pin *U* is obviously used for drawing the bolt back and indexing the fixture. Points worthy of note in the construction of this fixture are the liner bushing at *E*, the steel locating ring *L*, and the automatic method of taking up wear by the angular lock bolt *M*.

### Fixture with Inserted Jaws for Steel Casting

The work shown at *A* in Fig. 4 is a steel casting which has to be finished on the inside. These castings are made in two sizes, one of which is 1 inch larger than the other. It was desired to use the same fixture for both pieces in order to avoid the expense of making two fixtures. (The larger piece of work is shown in the illustration.) For this purpose a fixture *D* was designed to be screwed to the end of the lathe spindle in the usual manner. There are four jaws *B* which rest in slots around the inside of the fixture, these jaws being drawn back into their seats by the screws *C* in order to be ground in place to the correct diameter. Beyond the ends

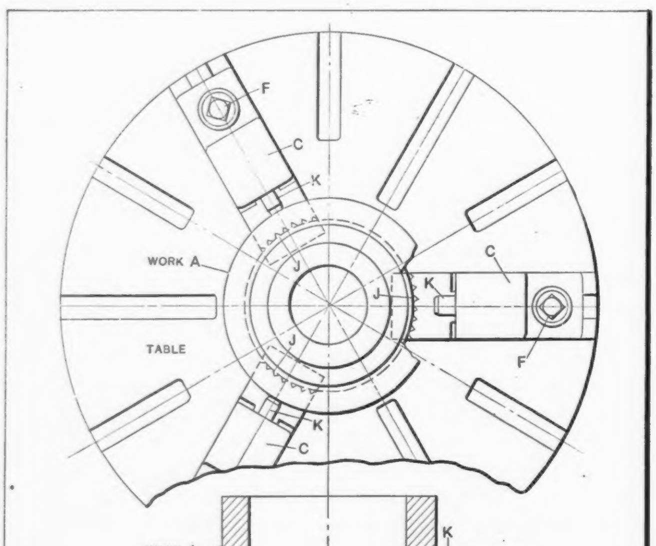


Fig. 6. Special Interchangeable Jaws for supporting Tall Work on Vertical Turret Lathe

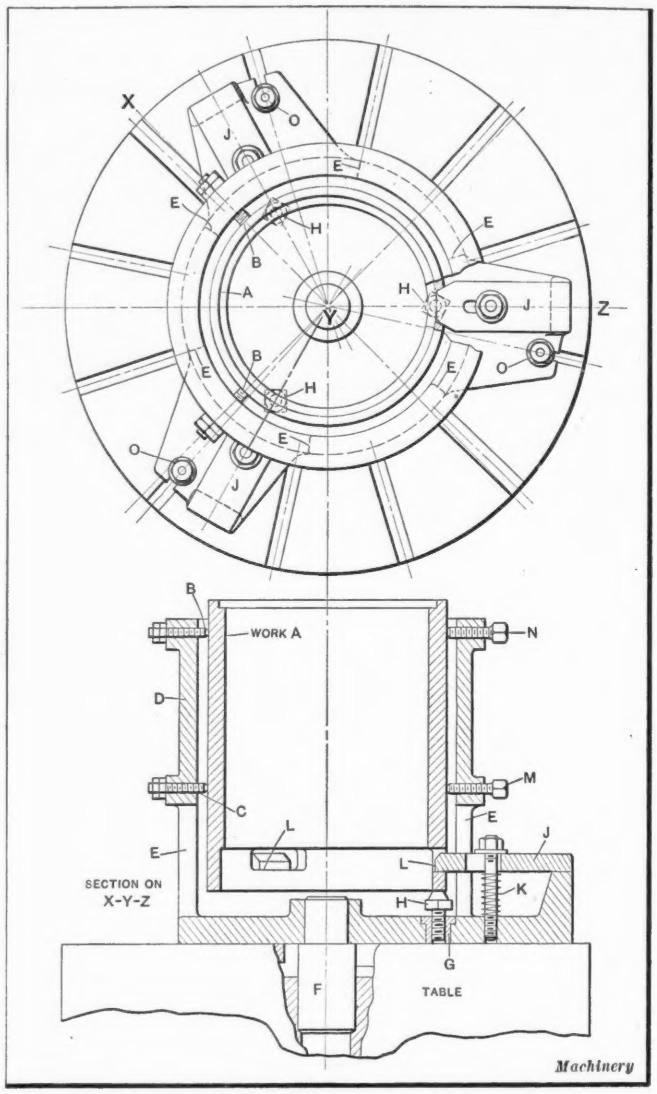


Fig. 7. Fixture for holding Casting A which is to be finished by a Single Operation

of the jaws, the pointed hollow set-screws *H* are so placed that they will come opposite to the web portion of the casting. By placing them in this manner it is evident that the entire width of the web will resist the strain of the screws so that they will not distort the work. Further than this, the screws *H* act as drivers, as they sink slightly into the work when set up. Two holes *G* are drilled at opposite sides of the fixture, these holes being utilized to force the work out of the jaws when removing it from the fixture.

A hardened and ground tool steel bushing *E* is placed in the fixture, and acts as a pilot for the cutter-head used in machining the work; and it will be noted that the surface *F* of the fixture is relieved to permit the passage of the tools through the work. In machining the smaller piece, it is only necessary to remove the jaws *B* and hollow set-screws *H*, and substitute those suited for the smaller piece. Therefore, one fixture was found sufficient to handle both pieces and replacements were made easy by the construction. Adaptations of this type of fixture may be made for many varieties of work, when several pieces are to be handled, and it will be found both efficient and economical in up-keep.

### Bevel Gear Fixture with Adjustable Features

The work *A* shown in Fig. 5 is a ring bevel gear blank of heavy section, which has been partly machined. In this instance the fixture is really composed of two separate pieces, one of which *B* is screwed to the nose of the spindle while the other *C* is adjustable on the first piece. It will be seen by reference to the illustration that the piece *C* is clamped firmly against the body *B* of the fixture by the steel clamping ring *D* and the screws *E*, and it will further be noted that there is a slight clearance between the outside diameter of the body *B* and the inside of part *C*. Three set-screws *F* are equidistantly placed around the periphery of the ring *C*

and these set-screws are furnished with check nuts as shown. By loosening the collar *D* and manipulating the set-screws *F*, the working portions of the fixture can be readily trued up when they become slightly out of true through use or abuse. A steel locating ring *N* is forced on to the ring *C* and is ground to the size of the interior gear.

The method of clamping is somewhat out of the ordinary, consisting of the use of three clamps *G* and an operating screw *J* and a floating collar *K*. The three clamps are placed 120 degrees apart and have slightly oversize holes through which the screws *H* pass. These screws have a ball surface on the under side of the collar corresponding to a similar depression in the clamps themselves. A steel bushing *M* is fitted to the body *B* of the fixture, and is threaded with a coarse pitch thread which corresponds to that on the operating screw *J*. After the clamps *G* have been swung into place on the ring gear, a few turns of the screw *J* sets all three of them with a uniform pressure through the medium of the spherical collar *K* which bears against their inner sides. It will be seen that although a fixture of this kind is somewhat expensive in first cost, all the parts can be readily replaced at a minimum expense and the fixture may also be kept true with the center of rotation of the spindle with very little trouble.

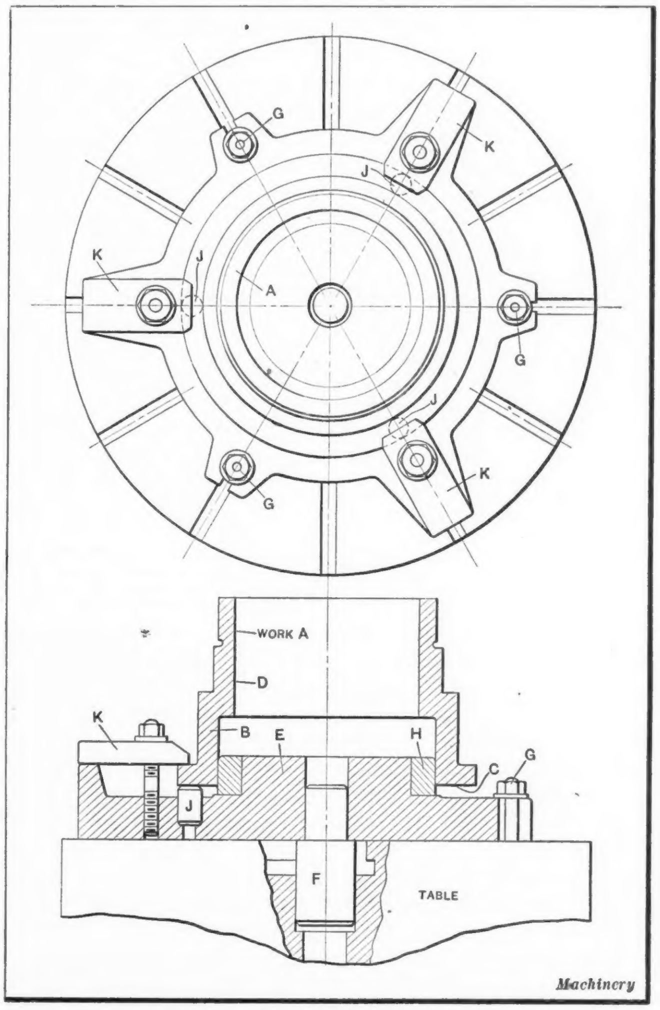


**Fig. 8. Fixture for performing Final Machining Operations on Partially Finished Casting A**

### A Set of Jaws with Replaceable Features

The heavy hub casting shown at *A* in Fig. 6 is to be bored to the three diameters shown in this illustration, the vertical turret lathe was selected as the machine on which the work was to be done. As the casting was somewhat long, it was necessary to give it more support than would ordinarily be possible with the regular jaws, so that the special jaws shown were designed for this purpose. The body *C* of these jaws was made of steel, and was tongued to the sub-jaws of the table at *D*, being secured in place by the screws *E* and *F*. The auxiliary jaws *B* were shouldered and serrated at *J* to hold the lower portion of the hub. They were tongued at their outer end *H* and drawn up against the surface of the main jaws by the screws *G*. The upper portion of each of the jaws *C* was furnished with hollow set-screws *K* which were of the cup variety, a socket wrench being used at *L* to operate them. In use these screws are pulled back out of the way and the work centered by means of the auxiliary jaws after which the screws are tightened lightly against the upper portion of the casting in order to prevent vibration. As these castings were of steel there was considerable wear on the inserted jaws due to the sand and grit in the castings, but as both jaws and set-screws were readily replaceable the provision for the up-keep was excellent.

### Pot Fixture for an Electrical Piece

The work shown at *A* in Fig. 7 is part of an electrical machine, which is required to be finished in one operation. Three holes are provided in the casting at *L* for clamping purposes only. The body of the fixture *D* is of cast iron, and is centered on the table by the plug *F*. Three screws *O* are provided to hold the fixture in place. The vee principle is used in locating the work; the four set-screws *B* and *C* form the angle of the vee, and the casting is pushed firmly over against these points by the screws *N* and *M* on the opposite side of the fixture. The work rests on the three screws *H*, these screws being adjustable for height so that they may be operated in such a way as to both tip the casting or to secure a firm support. The pot casting which forms the body of the fixture is cored at the three points *E* both for the removal of chips which would naturally accumulate on the interior, and also to provide access to the adjusting screw *H*. In order to provide against wear, the bushings *G* are set into the base of the fixture and are threaded to correspond with the adjusting screws. The clamping is accomplished by the three clamps *J* which draw the casting firmly down on the adjusting screws. The springs *K* simply keep the clamps up when they are not in use. By making the set-screws *B* and *C* adjustable, it is possible to take care of variations in a lot of castings by making suitable changes in the screws, and, as very frequently there are changes caused by two or more patterns being used, this point is very valuable.

### Fixture for a Hub Casting

The work *A* shown in Fig. 8 is a hub casting which has been previously machined on the surfaces *B*, *C*, and *D*. The fixture *E* on which it is held for subsequent operations is made of cast iron; it is centered on the table by the plug *F* and held down by the screws *G* which enter the table T-slots. A steel locating ring *H* is forced on to the body of the fixture and forms the point of location for the work. Three studs *J* are set 120 degrees apart in the base; and they are surface ground to the correct height to support the work. This arrangement makes locations positive regardless of chips or dirt. The clamps *K* hold the work down on the pins *J*. Features of this fixture are the ease of replacement of the locating rings and points, and freedom from trouble which might be caused by an accumulation of chips or dirt.

* * *

The Pennsylvania R. R. operated 69,306 passenger trains in the month of June, 1915, and 90.7 per cent of them arrived at their destinations "on time." Ninety-four per cent made the schedule time on their runs. A train may leave one terminal 5 minutes late, make its schedule time over a division, and arrive at its destination 5 minutes late. Any train not over two minutes late is counted "on time." The Buffalo division operated 971 trains in June and 98 per cent of them were on time. The Allegheney and Monongahela divisions had 96.8 per cent of their trains on time, while the Bellwood and Baltimore divisions had records showing a fraction over 95 per cent on time. Ninety-nine per cent of the passenger trains on the Bedford and Bellwood divisions in June made schedule time, while the records for the Buffalo, Cresson, Renovo, Allegheny and Tyrone divisions showed that over 98 per cent made schedule time. Only one division was under 90 per cent. The records show there has been a steady improvement in the past year in the number of trains arriving on time and making schedule time over the divisions.

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## THE SCIENCE OF MACHINE TOOLS

The undoubted lack of adequate knowledge of the principles underlying the cutting of metals is obvious to those who have tried to depart from the beaten path of machine-tool and cutting-tool development. In steam engineering, the principles governing the action of steam have been laid down mathematically. In electrical engineering, the refinement of scientific knowledge has been carried to such a degree that the efficiency curves of an electrical machine of a new type may be drawn before the machine is even designed on paper. In the machine-tool field, however, the design of a new machine is not based upon exact principles, but simply upon a knowledge of what it has been practicable to do in the past, and a reasonable judgment as to what might therefore be expected. Hence the many possibilities in the art of cutting metals are as yet far from being realized, even with the aid of the best modern machine tools.

Are these statements borne out by facts? In the most thorough experiments so far made in the cutting of metals, the investigator has developed a new kind of steel, and laid down certain laws as to the method of obtaining the best results, but he has retained essentially the old form of cutting tools, without questioning their value as compared with other possible forms. A later investigator finds that by a radical change in the cutting tool itself and also of the principle of removing the chips, cutting-speeds four times as high as the best previous results, may be obtained. How much more can be done is uncertain, as the theory of metal-cutting is practically unknown. We do not yet fully understand what takes place when a chip is severed from a bar, nor do we know why the chip and the tools heat up. We know very little definitely about cutting-angles of tools. A. L. DeLeeuw, who has made some interesting and valuable experiments along these lines, finds that a tool with an inclined angle of 25 degrees applied in a radically new way to the work (the tool being circular, and rotating as it cuts), will stand up for an unprecedented amount of work as compared with the best regular lathe-tools. In fact, these tools have so great a capacity for removing metal that no existing types of machine tools have the power and rigidity required for their regular use.

In steam engineering, which has been reduced to a science, it is possible to state within quite close limits what is the highest efficiency obtainable from one pound of coal of a given quality; in electrical engineering, the percentage of efficiency from the prime mover to the motor may be determined to a nicety; but in the removal of metal, we have not yet determined the fundamental laws of metal cutting. We cannot say how much power is really necessary, for example, to remove a pound of metal under certain conditions. We know little as to the limitations of efficiency of machine tools; but we know that a very large percentage of the power expended in driving a machine is wasted in friction before reaching the cutting point and we know that we have not reached the limit of efficiency in shaping cutters.

* * *

## STANDARDIZATION OF DRAWINGS

One of the commonest causes of mistakes and misunderstandings in manufacturing is the lack of uniformity of practice in making drawings. The evil is particularly felt in jobbing shops which bid on contracts after having studied the drawings submitted. Frequently these drawings leave much to inference and imagination, but it is a serious matter to bid on a product in the belief that a certain standard of manufacture is required when a higher or a lower one is wanted. If the would-be contractor assumes that the standard is too high, he probably bids too high, and if he assumes that it does not call for high-grade work, his bid may be too low for making a living profit.

The paper "Reform in Drawings" read by Mr. Fish before the National Machine Tool Builders' Association Convention called attention to the mistakes which result from the misunderstanding of drafting-room conventions and practice, not in accord to commonly accepted methods. Here is an opportunity for the Society of Automobile Engineers to add to its already great work of standardization by fixing conventions —by the expression of limits and tolerances, the placing of dimensions, uses of dotted and broken lines, etc.—in short everything which makes a drawing a conveyor of specific instructions for making a part.

The work of standardizing drawing practice will doubtless be extremely difficult, but if a national body of engineers were to adopt a standard of practice, it would soon be used in the technical schools and in up-to-date manufacturing plants.

* * *

## THE MACHINE TOOL INDUSTRY

Never was there a time when the machine tool trade looked brighter than it does at the present moment. The demand for engine and turret lathes, milling machines and other machine tools employed in the manufacture of shrapnel, explosive shells and rifles, is unprecedented; and the indications are that this will continue for some time. This boom in the industry recalls other periods of sudden and extraordinary demand like that which accompanied the remarkable development of the bicycle industry in 1896, and of the automobile industry in 1906. But, while the bicycle industry rapidly declined, the automobile business shows little indication of lessening in the immediate future.

The introduction of the automobile had a far-reaching effect upon the machine tool industry and machine tool design. The demand for high-grade materials capable of withstanding shocks and stresses of high-speed cars, made it necessary to design machine tools capable of working the metals at economical speeds and feeds. These demands, in turn, showed weaknesses in machine tool design and construction. For example, it showed that cast-iron gears were entirely inadequate in many cases. Consequently, the constructions which had been found reliable in automobile design, were adopted and used in modified forms in machine tools.

Under the heavy pressure of war orders from abroad, the builders of machine tools and other machines used in the manufacture of munitions of war were confronted with the problem—How may capacity be increased? To greatly increase capacity is not an easy matter. To build new plants or to add extensively to old ones if often inadvisable—especially when the demand for a product is abnormal. The safest policy for meeting the emergency is to utilize the present facilities more than ten hours a day; and this means probably the organization of a night force.

# CARBURIZATION AND HEAT-TREATMENT*

## THE CARBURIZATION OF STEEL AND THE HEAT-TREATMENT OF CARBURIZED PARTS

BY J. GERRISH AYERS, JR.†

FOR certain uses steel parts are required to resist wear and at the same time be sufficiently tough to withstand shocks. Unfortunately, toughness and hardness are two properties which are completely opposed to each other in steels. If we harden a 1.00 per cent carbon steel so that we obtain the hardness desired, it will be too brittle to withstand loads or shocks. If we then draw it back or temper it so that it possesses the requisite toughness, it will lose too much of its hardness to answer our purpose. On the other hand, if we choose a 0.20 per cent carbon steel, which would possess the desired toughness, it would be incapable of becoming hard enough.

It is obvious that the ideal steel for this purpose would be one which was high in carbon at the portions we required hard and low in carbon elsewhere, to obtain the requisite toughness. There is but one way to obtain such steel; this is by the carburizing process.

In this process, steel parts of low carbon stock are packed in metal boxes or pots with a carbonaceous compound. Those portions of the steel which are required to be hard are surrounded with the compound, while those portions which are to be soft and tough are surrounded with sand, or otherwise suitably insulated from the action of the compound.

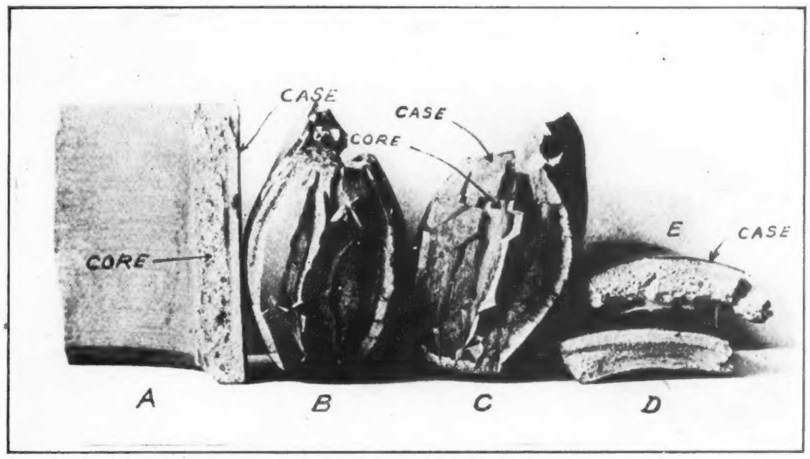


**Fig. 1. Samples of Carburized and Heat-treated Steel showing Difference in Results obtained**

These pots are then sealed and placed in a carburizing oven or furnace and maintained at a heat of 900 to 1000 degrees C. (1652 to 1832 degrees F.) for a length of time depending upon the extent of the carburizing action desired. By so doing, carbon derived from the carburizing compound is absorbed by the steel at the spots desired and the low carbon steel is converted into high carbon steel at these portions, while the insulated spots retain practically their original low carbon content.

We therefore have obtained exactly what we required—a steel of dual nature—a high carbon and a low carbon steel in the same piece. After the steel has been carburized it must be heat-treated to develop its properties of toughness and hardness to the fullest extent. As we now are dealing with a steel which is in reality two steels in one, a high and low carbon, it is obvious that to heat-treat it correctly we must give it two distinct heat-treatments, one to suit the high carbon portion or case, as it is termed, and one to suit the low carbon portion or core.

Fig. 1 shows pieces of steel so treated. Piece *A* shows poor heat-treatment resulting in an incompletely refined core; *B* and *C* show pieces perfectly treated with the case clinging to the core even after the pieces are bent double upon themselves; *D* and *E* show fractures of alloy steel with fine case and core. Having thus briefly described the process, we will be in a better position to proceed with its study in detail.

### Theory of the Carburizing Action

When it is difficult to explain the chemical or physical action involved in a process, there are generally a host of theories advanced. This is true in the case of the carburization of steel. We will not dwell here upon the many hypotheses and theories evolved in the past for the explanation of the carburizing action as we are more interested in present-day opinion.

The carburization of steel may be effected by gas, liquid, paste or solid preparations. The last medium is under discussion in this article, being in more general use. The fact that carburization can be effected by gases alone has led to a series of researches by various investigators as to just what gases play the major part in the process. It has in consequence been found that the carburization is effected chiefly by carbonaceous gases, principally carbon monoxide and volatilized cyanogen compounds.

The former gas results from the partial combustion of the carbon contained in the carburizing compound, the latter from the decomposition of cyanide compounds contained in the mixture or from a combination of atmospheric nitrogen with the carbon in the compound. Carbon by itself has practically no effect. As the carburizing gases mentioned diffuse through the metal converting the outer portion into higher carbon steel, there is at the same time a diffusion of carbon from these more highly carburized zones inward toward the lower carbon interior of the piece. In this manner, the penetration of carbon extends deeper and deeper as the time of the action is prolonged.

It must also be observed that not only does the heat of the furnace convert a portion of the solid carburizing compound into effective carburizing gases, but it also heats the steel to a temperature at which the iron has a pronounced affinity for carbon. Carburizing action may take place as low as 560 degrees C. (1040 degrees F.), but commercially not below 849 degrees C. (1560 degrees F.).

### The Carburizing Compound

We have already observed the manner in which carburizing takes place. To one who is familiar with the theory, it is obvious that there must be many compounds which, from a chemical standpoint, will produce the desired action. It is perhaps due to this that so many different compounds are on the market and each is giving satisfaction to its own circle of adherents.

In different shops different classes of work are handled. Each must meet certain requirements. A mixture which would give satisfaction in one case might be entirely unsatisfactory in another. Where very small amounts of the compound are used each day, the cost per pound is not such a vital or impressive factor as where several tons are used. In the former case, rich cyanogen compounds, very active, giving rapid penetration, may find favor in spite of their short life due to rapid deterioration.

On the other hand, where large heavy pieces, requiring extreme depths of case, and hence, long runs in the furnace, are handled, a short-lived mixture would not be suitable. With solid work, such as shafts or arbors, which require no packing with sand or other insulating material, a finely ground mixture may be employed, but where sand is used

* For other articles on carburizing and the heat-treatment of steel see "Automatic Heat Control" in the December, 1914, number of MACHINERY; "Locating the Critical Range with the Brinell Ball Tester," December, 1914; "A Modern Heat-treatment Plant," September, 1914; "Some Recent Improvements in Casehardening Practice," August, 1914; "Hardening Bolts by the Ton," June, 1914; "Gas and Oil Fired Furnaces for Heating Steel," May, 1914; "The Accurate Heat-treatment of Roller Bearing Parts," April, 1914, and articles there referred to.

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a coarser mixture which can be separated from the sand by screening is advantageous. It can therefore be readily seen that there is much diversity in requirements for compounds and this accounts in some measure for the diversity of opinion as to their respective values and efficiencies. There is no one compound which is ideal in all respects and only the uninitiated will recommend one particular compound for general application to all classes of work. As soon as investigators recognize this point their results will be of more practical value. Each metallurgist should study his own particular requirements and then strive to produce a compound to fulfill them.

When an extremely rapid rate of penetration is required cyanide compounds are frequently employed. A molten bath of potassium cyanide gives a very rapid penetration, but

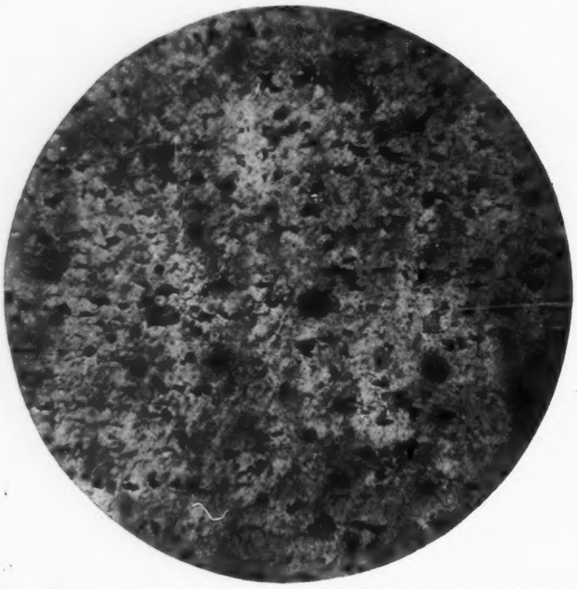


Fig. 2. Photomicrograph of 0.12 per cent Carbon Steel. Magnification, 300

only a superficial case. It is not effective for extreme depths of penetration and its use has many disadvantages, due to the dangerous nature of the gas given off. It is frequently added to compounds to aid them in giving rapid action and a very intense concentration of the carbon.

Even for this purpose it is not to be recommended, as due to its rapid deterioration, it soon constitutes an inert element in the mixture, particularly where it is customary to use a batch of the compound repeatedly with a certain renewal of fresh material. Compounds of cyanide such as prussiate of potash (potassium ferro-cyanide), while not quite so energetic in their action, are less dangerous to handle.

Wood charcoal is one of the best bases for a compound. It is a good carburizer and is to be particularly recommended on account of its long life. It should always be used in conjunction with some other element, as alone it has too slow a rate of penetration for commercial carburizing. In Europe it is frequently mixed with various proportions of barium carbonate and has found much favor. This mixture, however, requires a temperature of at least 1000 degrees C. (1832 degrees F.) to give its most efficient results. This temperature is higher than is considered good commercial practice and entails excessive deterioration of pyrometers, pots and furnaces, and in some cases the steel itself. When cyanide is added to the mixture there is also a tendency for fusion to take place at this temperature, and the ware does not come out of the pots clean and free from adhering particles. Some of the proportions recommended by various investigators are given below:

*A* 40 parts by weight barium carbonate.
60 parts by weight wood charcoal.

*B* 60 parts by weight barium carbonate.
40 parts by weight wood charcoal.

36 parts by weight barium carbonate.
*C* 54 parts by weight wood charcoal.
10 parts by weight potassium ferro-cyanide.

Of late, wood charcoal derived from poplar wood has been recommended, due to its low sulphur content. Mixture *A* gives a very high carbon content; mixture *B* produces a case lower in carbon and less likely to chip off, due to brittleness; mixture *C* gives perhaps the highest carbon content at the extreme outer zone of the case.

All of these mixtures compounded with barium carbonate require a minimum temperature of about 1000 degrees C. (1832 degrees F.) to act efficiently, as has already been noted. They also have a tendency to render the ware very dirty as it comes from the pot after cooling down. In some cases a decided blistering of the surface of the ware has also been noticed.

Mixtures of charcoal, burnt leather, charred bone, and boneblack in various proportions and combinations are frequently employed. There is apparently quite a latitude in the proportions which may be used to give satisfactory results. The charcoal acts as a base to which the other ingredients impart their respective properties. Compounds of the above nature are not likely to fuse at temperatures below 1000 degrees C. (1832 degrees F.) and generally produce ware which is free from any soot or other matter adhering to the surface.

Compound *D*, given below, would be a characteristic one of this class and gives very satisfactory results. When employed at a temperature of about 960 degrees C. (1760 degrees F.) it exhibits good penetration, gives a case which is not likely to chip off and ware which is remarkably clean and bright on the surface.

35 parts by weight wood charcoal.
*D* 30 parts by weight burnt leather.
35 parts by weight charred bone.

In making compounds we fortunately have a ready means for arriving at their particular advantages by actual comparative tests. This is really the best and most practical way to develop a compound suited for any particular case. If possible, the steel employed in these tests should be of the same analysis as that with which the compound is to be

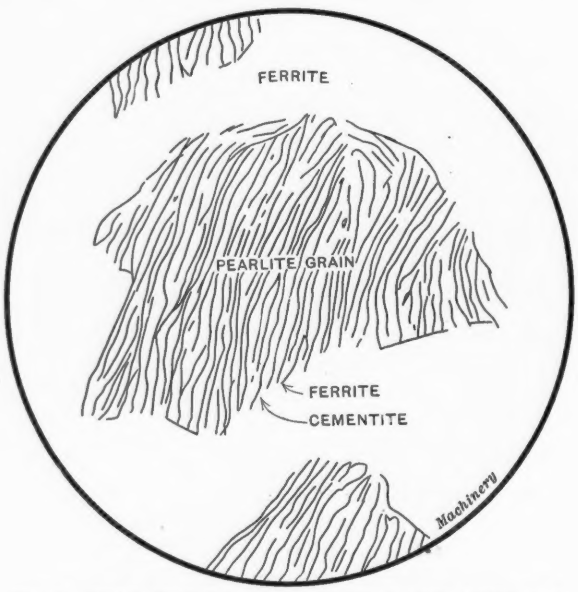



Fig. 3. Sketch illustrating Appearance of Pearlite Grains at a Magnification of 1000

employed. In addition to this, to make the test strictly comparable the specimens should be cut from the same bar of stock. If this is impossible, careful analysis should be made to insure that all specimens are from steel of practically identical analysis. Cylindrical pieces presenting a circular cross-section are more suitable than those of rectangular cross-section, as they absorb the carbon to a more uniform depth. In no case should extremely small sections be used to test the compound for deep penetration, as the case will then practically extend almost through the piece and it will be very easy to make an error in estimating its exact depth.

In a test of this nature we are particularly interested in determining the following factors: The rate of penetration, the quality of the case, and the cost per cubic foot of the compound.

Having obtained specimens meeting the requirements already mentioned and all of the same size, we may pack, say, about six each in pots containing the several mixtures under investigation. Round pots are to be preferred to rectangular ones, for they give a more uniform heat throughout their interior, and hence the test specimens will be acted upon more uniformly. The temperature of the carburizing furnace and the duration of the run should be the same as the practice in the shop. These factors are very important, as some carburizing compounds give very satisfactory results for short runs, but rapidly deteriorate as the time in the furnace is prolonged. The same variation in results may be caused by the effect of different temperatures on various compounds.

When the run has been completed, several courses of procedure are open for heat-treatment and examination of the specimens. It must be borne in mind that the long run in the furnace at a high temperature has given very favorable conditions for the formation of large coarse grains in the steel specimens, both in the case and the core, particularly the latter. If we quench directly from the pot we will be able to refine the core to a certain extent, but the case will be extremely coarse. The results, however, are often satisfactory enough to define the limits of the case and core. A better method is to follow this first quenching by a second heat-treatment and quenching at a temperature which is lower and suited to refine the case. The ideal method, from the standpoint of perfectly refining the case and core, is to allow the work to cool in the pot and then give it two heat-treatments, one exactly suited to refine the core and the second to refine the case.

After being satisfactorily treated, the test specimens should be broken in two and the depth of case given by each mixture determined. In breaking the specimens, one side is subjected to compression and the other to tension, and this often

Fig. 4. Photomicrograph of 0.42 per cent Carbon Steel showing Greater Number of Dark Grains. Magnification, 300

produces a great dissimilarity in the appearance of the fracture. In instances where the case heat has been very low and the specimen is of low carbon stock the core will be pulled over into the case and lead to the erroneous conclusion that the case is extremely thin at this point. Another heat-treatment of this specimen at a somewhat higher temperature with a fresh fracture will show the correct depth of the case. A little care and experience will soon prevent incorrect conclusions on this point.

## Quality of the Case

The quality of the case is a very important consideration. Some compounds give a high carbon case for a short distance into the specimen, beyond which the case possesses a decidedly lower carbon content. Others give a fairly uniform carbon content over the greater portion of their penetration. The running temperature is also a factor which affects the distribution of the carbon in the case and it is for this reason that it is recommended to run the test at the same temperature as is in vogue in the shop.

The query naturally arises as to what constitutes a case of high quality. This point depends, just as should the nature of the compound, upon the requirements of the work. If a heavy load is to be carried by the article a deep case will be required, particularly if the core is of very low carbon steel. If the surface required must be extremely hard a case of high carbon content is essential. If the article has many sharp corners or very thin portions, which might give an opportunity for the case to chip off, we must lower the carbon content to suit this requirement.

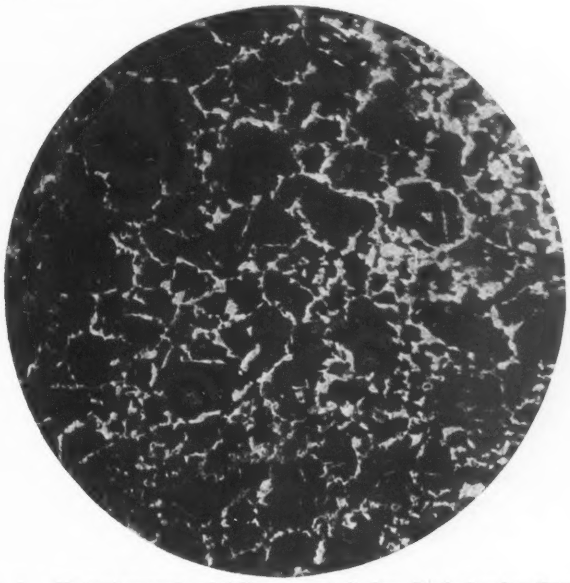


Fig. 5. Photomicrograph of 1.00 per cent Carbon Steel showing Excess of Carbide of Iron or Cementite Grains. Magnification, 100

We must also bear in mind that it is not the extreme outside surface of the piece as it comes from the carburizing furnace that must conform to the requirements as regards carbon content, but that portion which will be exposed after the finished grinding operations. For example, a piece might be carburized to 1.00 per cent carbon content for a depth of 0.015 inch after which the content might lower to about 0.70 per cent. If the grinding process should remove 0.025 inch, as is sometimes the case, we would then have exposed a 0.70 per cent carbon zone which would not give us the desired hardness.

To make an accurate determination of the extent and character of the different zones of the case would require a very careful and laborious analysis of successive layers. In this connection we may more wisely resort to the use of the metallurgical microscope which has proved of inestimable value for this purpose. Its efficient use, of course, requires a certain amount of experience and knowledge of the principles of metallography. We will only briefly outline the theory and procedure here, as this knowledge can best be acquired in the many excellent works on this subject.

Steel as it leaves the manufacturer may be in any number of different states as regards its microstructure. In order to study it under the microscope it should be heated to about 1000 degrees C. (1832 degrees F.) and then cooled very slowly. The different constituents then appear in what is called the normalized state and we can resolve one from the other. The steel must then be polished with successive grades of abrasives until a mirror-like polish has been given to its surface. The steel is then etched with a suitable reagent which acts unequally upon the different constituents, turning some darker than others, so they can be distinguished under the microscope.

If we now examine a piece of low carbon (about 0.12 per cent) steel under the microscope it will appear as shown in Fig. 2. The dark grains are called pearlite. The white background is called ferrite, and consists principally of iron with a few impurities.

If we examine the dark grains at a higher magnification,

they will appear as shown in Fig. 3. The white laminations are carbide of iron $Fe_3C$ called cementite and the dark laminations are ferrite. In other words, a piece of low carbon steel, treated as mentioned, consists of a white background of iron or ferrite, interspersed with a few dark grains which consist also of some ferrite or iron in laminations or layers separated by laminations of carbide of iron, or cementite. We may summarize thus:

White background = iron = Fe = ferrite.

Dark grains = iron + carbide of iron = $Fe + Fe_3C$ = pearlite.

If we examine higher carbon steel, treated in the same way, we will notice that the chief difference in appearance is a larger number of dark grains, due to the increase of carbon. See Fig. 4. It is obvious that there must be a steel of high enough carbon content to be composed of all dark grains and no white background. This steel would, therefore, be composed wholly of pearlite. If now, we examine a steel with still more carbon, we will notice a re-appearance of the white grains, but in this instance they are carbide of iron or cementite grains, as this would naturally have to be the excess element when we increase the carbon. See Fig. 5.

Steel which is composed wholly of pearlite is called eutectoid and contains from 0.80 to 0.90 per cent carbon. All steel under this in carbon content is called hypo-eutectoid, and all steel over 0.80 to 0.90 per cent is called hyper-eutectoid. The foregoing facts should be thoroughly understood as they are the ABC of metallography.

If we take a piece of this normalized steel and heat it to, say 840 degrees C. (1544 degrees F.) and quench in water, it will become hardened. If we now repolish, etch and examine again under the microscope, we will be unable to observe any large dark and light grains, but a very fine structure lacking in any particular detail. It would seem as if this treatment had caused the grains we observed before, to become merged together into a solid solution. This is just what has occurred and the steel is in the state of a solid solution. The main difference between a solid solution and a liquid one is that the former takes place among the constituents of a solid. Heating the steel to this temperature has allowed the solution to form, and cooling it suddenly has locked the steel, so to speak, in this condition. If we now reheat the steel or draw it back, starting with a low heat of, say, 149 degrees C. (300 degrees F.) and increase it, the steel gradually returns to the normalized state if we heat it high enough. While doing so it naturally passes through several transition states. These are starting with the solid solution state, called: austenite, martensite, troostite, sorbite, and pearlite.

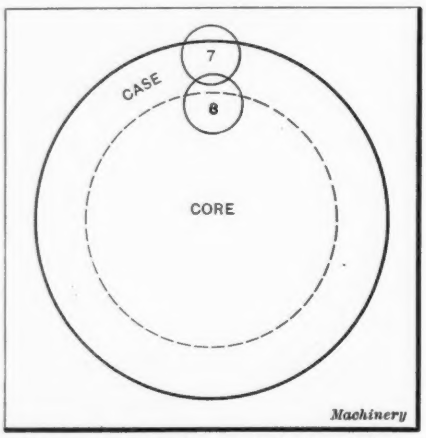



Fig. 6. Cross-section of Carburized Piece showing Location of Portions shown in Figs. 7 and 8

In other words, this reheating and cooling without any quenching, unlocks the structure of the steel and allows it to return closer to the normalized state. Having thus briefly described these points, let us examine microscopically a piece of carburized steel which has been normalized, polished and properly etched. We may naturally expect to find all variations of carbon content from hypo-eutectoid in the core through eutectoid to hyper-eutectoid in the outer zone of the case. In fact, actual examination shows this to be true.

Fig. 6 represents a cross-section of the carburized piece and will serve to make clear the locality on the piece of each photomicrograph.

Fig. 7 is a photomicrograph which shows a portion of the bar from the outer edge inward almost through the depth of the case. We note the outer hyper-eutectoid zone where the light network is excess cementite, the succeeding eutectoid zone consisting of pearlite with practically no excess constituent, and next the hypo-eutectoid zone with pearlite and light ferrite grains.

Fig. 8 is a photomicrograph taken at the spot indicated in Fig. 6 and shows a part of the same portion of the specimen as shown in Fig. 7. The two white lines ruled through each photograph show where they might be cut and joined to make a continuous view. We note in Fig. 7 that the hypo-eutectoid zone as it extends inward toward the center of the bar, possesses fewer and fewer dark grains until we arrive at a point which is representative of the steel before it was carburized. It will be noted that in addition to the jet black pearlite grains there are apparently other dark grains although of a considerably lighter hue. These are ferrite grains which, due to different orientation of their crystalline matter, etch to different shades. The darker shading around the edges of the photograph is due, however, to unequal illumination of the specimen while being photographed. These effects cannot cause confusion in determining the pearlite grains, as they are so much darker.

In photomicrographs, Figs. 7 and 8, is shown a specimen which represents a good carburizing process. The case will be hard when heat-treated and will adhere well to the core. It sometimes happens, however, when a very high carbon case is obtained that the cementite instead of surrounding the grains in the form of a network actually penetrates them and by thus breaking up the continuity of the structure forms a very brittle article.

By careful study, one may become able to judge of the quality of the case as regards the extent of its zones, their carbon content and the physical structure of the case and core. Unfortunately in the present state of the microscopy of iron and steel, no satisfactory test has been evolved for the determination of the sulphur or any occluded gases. Where possible this should be obtained by chemical analysis, as it has a very important effect upon the quality of the article. If in determining the quality of the case we have no microscopical outfit at hand, we may test as follows:

After the specimens have been heat-treated and the depth of case determined, we should then proceed to test the surface for hardness, at successive depths (obtained by grinding) by either the file, scleroscope or Brinell ball tester. Having already become familiar with the requirements of the particular parts under test, we can readily find at what depth they cease to have the necessary hardness. This method does not compare with the microscope in giving complete details, but it is often sufficient for all practical purposes.

### Cost of the Compound

The cost of the compound should be based upon volume and not weight, as a pot is always packed until it is filled and not with a given number of pounds. This is an essential point, and although very obvious is often overlooked. Most compounds are sold by the pound and to get a comparison of the cost we should convert this into cost per cubic foot. Having thus tested out the various compounds, we can then very readily form an opinion of their relative properties and value for the purpose in hand. We will now consider that we have chosen a suitable compound and proceed with the discussion of the actual operations in the shop.

### Packing

In regard to the packing, we may divide the work broadly into two classes: first, straight packing, where the piece is carburized over its whole surface; and second, the packing of insulated work. We will discuss the former class of packing first.

In order that pieces be as evenly carburized as possible, it is essential that all portions be heated uniformly. Unfortunately, under commercial operating conditions it is impossible to realize this fully, but we may take certain precautions that will greatly aid in obtaining this object. The pot itself should be so designed that it permits the heat to have equal access to all of its sides, top and bottom. A pot

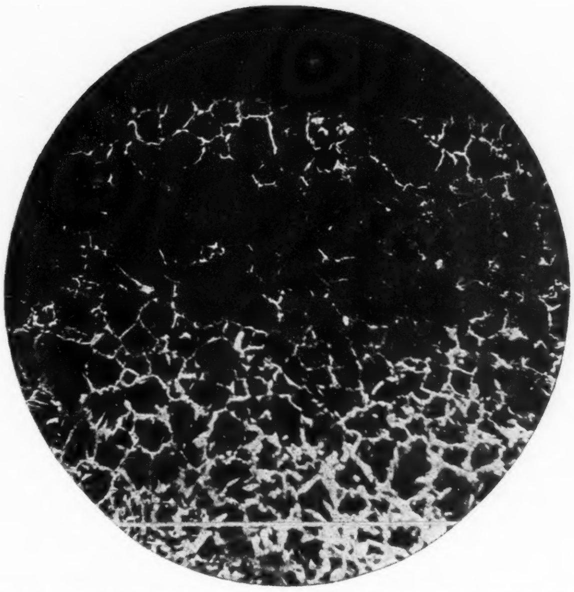


Fig. 7. Photomicrograph of Outer Portion of Case. Magnification, 50

which takes almost the entire width of the furnace, but does not occupy so much of the length of the furnace will not heat equally. When several pots are placed in the furnace they should be spaced far enough apart to give the heat free access. If they are banked together the outside parts will be heated more rapidly than those in the center and the ware in the pots will not be carburized uniformly. In some furnaces the portion of the oven space nearest the door is considerably lower in temperature than the back of the furnace, due to the loss of heat through the door, which is not as good an insulator as the furnace walls. In this case the furnace should not be loaded so close to the door.

In packing the work in the pots care should be exercised to see that there is a tightly packed layer of carburizing compound of an inch or more in the bottom of the pot. If the parts are heavy this should be increased so that they cannot settle through the compound and come into contact with the pot walls. A layer of the parts to be carburized should be placed upon this layer of compound and more compound packed tightly above them. Alternate layers of ware and compound should be thus packed until the pot is filled to within an inch or so of the top. The uppermost layer of compound should be amply deep to allow for any settling or burning of the compound during the carburizing process. If this precaution is not observed the ware at the top of the pot may become exposed and its surface will not respond to heat-treatment. No fixed rule can be given for the location of the parts in the pot, as their size, weight and shape govern this. They should, however, be so spaced that neither jarring nor settling will cause them to come into contact with each other or the pot walls.

In packing insulated parts which are to be carburized only in certain portions, we are often confronted with problems which require considerable ingenuity to solve. Some of the simplest problems met with may be solved by the employment of sand as an insulating medium. For example, in the case of hollow cylinders or tubes which it is desired to carburize only on the inside, we may pack them one upon the other, being careful to keep them in good alignment. They may then be surrounded with sand outside and packed inside with the carburizing compound.

This will produce a case on the inside of the cylinder, while the outside will have practically no case. In this connection, it may be stated, that sand does not always entirely prevent the action of the compound upon the article, for some of the gas may penetrate the sand and produce a very slight case. Pure silica or beach sand is often less effective than sandy earth or clay, as the latter possesses finer particles and, because of the clay content, is baked into a more impervious mass, which better resists the penetration of the carburizing gases. Whatever medium is used it should first be thoroughly dried. When sand is used and it is desired to use the compound repeatedly with a certain amount of renewal by fresh compound, it is obviously necessary to have a mixture which is coarse enough to be readily separated from the sand by screening.

Instead of insulating with sand, as in the case just mentioned, caps may be placed over each end of the cylinder and held in place by a connecting bolt and nuts. This method is in quite general use and insulates more thoroughly than sand. Another method employed is to copper-plate the article at those portions which are desired to be insulated. The copper, having no affinity for carbon, prevents its passage into the steel. In this connection care should be exercised to see that the plating is done under correct conditions, as otherwise the plate chips off under the effects of the carburizing heat. Some compounds rich in cyanogen also attack the copper and render it ineffective. This is especially pronounced as the temperature of the process approaches the melting point of copperf, 1083 degrees C. (1981 degrees F.). It is also obious that the heat must be kept well below this temperature in order to avoid the danger of the copper running on the article. Still another method is to leave extra metal on the portions desired free from case. The article is then carburized all over, allowed to cool in the pot and the excess metal is then machined off, thus removing the case at the desired part. The article is then heat-treated.

In some instances it is necessary to use one or more of these methods on the same piece. It is here that the mechanical ingenuity of the metallurgist may be used to good advantage in devising new methods and combinations for doing the work efficiently.

After the parts are packed in the pot the cover should be thoroughly looted on with fireclay to which a small amount of salt may be added to prevent its cracking excessively under the heat. The pots may now be loaded into the furnace.

### Temperature of the Furnace

The proper running temperature is dependent upon several factors, so that no one temperature could be recommended as ideal. The following relations hold: The higher the temperature the more rapid the penetration and the richer the case is in carbon. It is, however, obvious that too high a temperature will make a very brittle case, will also have a deleterious effect upon the steel, may fuse the compound, and will entail excessive deterioration of furnaces, pots and pyrometers. Some steels, such as the alloy steels, can withstand a higher temperature without injury, than plain carbon steels. Certain mixtures, such as the barium chloride compounds, require a high temperature to produce their best results. As carburization does not take place efficiently below 849 degrees C. (1560 degrees F.), temperatures around 871 degrees C. (1600 degrees F.) will produce a slow rate of penetration. By going up to, say, 927 degrees C. (1700 degrees F.) we gain materially in production without in any

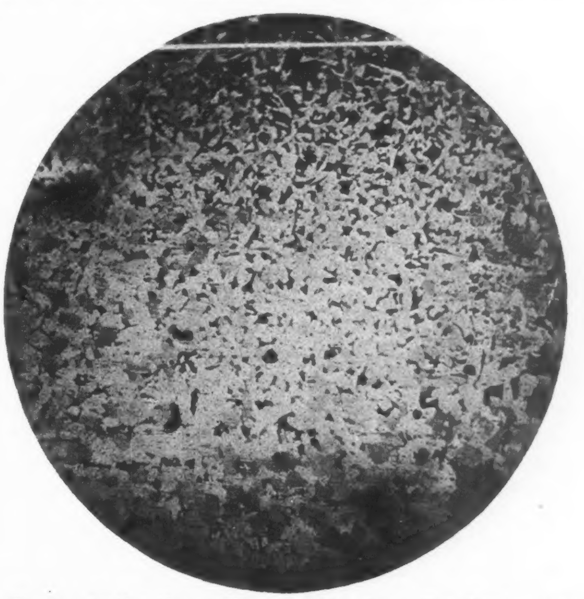


Fig. 8. Continuation of Fig. 7, showing Core. Magnification, 50

way injuring a good steel. As we get much above 982 degrees C. (1800 degrees F.) there is grave danger of injuring the steel. Broadly speaking, we may say that from 927 degrees to 954 degrees C. (1700 degrees to 1750 degrees F.) is a safe temperature for good steels and gives rapid enough penetration to satisfy most conditions.

### Duration of the Run

The duration of the run depends upon the depth of the case desired. We have already considered the most important factors, such as the amount to be removed in grinding, the zone desired at the surface, etc., which govern the depth of case it is necessary to obtain. It now remains to be seen how we are going to ascertain when this depth has been reached in the furnace, so that we may promptly unload it. If our steel was of absolutely uniform analysis, and all furnaces heated uniformly throughout, we could, by experiment, soon determine when to remove the charge in the furnace without actually inspecting the depth of penetration. Unfortunately these conditions cannot always be realized, so that the safest way is to remove a sample from the furnace and inspect. Our experience will soon permit us to estimate at least within a few hours when the depth of case has been obtained, and hence by withdrawing a sample or "dummy" well before the estimated time, we can tell just how much longer to leave the pots in the furnace. This dummy should be of the same steel as is in the parts being carburized, and as nearly the same in size and shape as possible—preferably one of the parts themselves. It should be conveniently located in the most accessible pot. At the time decided upon, the pot can be withdrawn from the furnace while the dummy is removed and the pot promptly reloaded again. The dummy may be quenched in water directly from the pot, reheated to a lower temperature to refine the case and quenched again. It may then be broken and the depth of case determined by the eye. From this procedure, which should not take over five minutes, we can estimate just how much longer to leave the pots in the furnace.

One precaution which is very important is the determination of how the temperature of the dummy pot compares with the other pots in the furnace, for if it should be much higher or lower the dummy would not be a safe indication of the depth of the case in the other pots. In many commercial furnaces there is considerable variation in temperature between different parts of the oven space and these should be thoroughly understood. This is particularly important in the carburization of articles of very thin cross-sections where a slight variation in penetration may result in carburizing entirely through the piece.

### Heat-treatment

The heat-treatment of carburized parts is perhaps one of the most difficult thermal processes. It often prevents difficulties which baffle the most skillful and experienced workmen and are apparently in contradiction of theory itself. To obtain mere hardness or toughness alone is not so difficult a task, but to obtain them both in the highest state to which they may be developed requires the most careful manipulation. Unfortunately, there has been a somewhat common belief that any low carbon steel should carburize successfully, and this has resulted in much inferior work which cannot be laid to heat-treatment. Of this we shall speak later.

In heat-treating the articles, the procedure should be governed by the nature of the work and the requirements it is to fulfill. If it is absolutely necessary to have the highest degree of perfection in hardness and toughness, the best procedure is to give the parts two heats; a first heat and quenching at a high temperature to refine the core and a second or lower heat and quenching to refine the case. As to whether water or oil should be used depends upon the requirements to be fulfilled later by the parts. Water gives a more drastic and penetrative quenching effect and produces a better defined case and core. It is more inclined to produce distortion of the article, however, especially in the high first or core heat. For this reason its use is sometimes prohibited more from a mechanical than a metallurgical standpoint.

For the second or case heat, water is far superior to oil, as it gives a greater hardness to the case and this is, of course, the sole object of the case, the core furnishing the necessary toughness. Here again, however, distortion of the article may be the governing factor in deciding upon its use. In some cases where very large and massive articles made from ill-chosen steel are carburized, it is impossible to get them uniformly file-hard without the use of ice-cold water or brine as a quenching medium for both heats. Ice-cold brine may be employed where the highest degree of hardness is desired.

In the two-heat method the parts should be allowed to cool in the pots until they are at least below the temperature at which they might scale on being exposed to the air. The pots may then be unloaded and the parts, after being brushed and wiped clean, placed in the furnace for the first heat. The importance of having the articles perfectly clean and free from oil and grease before being placed in the furnace should not be disregarded. This is particularly true of parts which have just emerged from a high first heat and quenching in oil. If this oil and loose scale (if present) is allowed to adhere, it will bake on during the second heat and result often in soft spots. The temperature of the first heat depends mainly upon the carbon content of the steel and the alloying elements, if any are present, and on the mass of the piece.

### Method of Procedure

For straight carbon steel of from 0.10 to 0.20 per cent carbon, the temperature will range from 843 degrees to 913 degrees C. (1550 degrees to 1675 degrees F.). A test specimen should be placed in the furnace, and the temperature giving the best refinement of the core determined. Where the pieces are large and massive, a higher temperature will be required to obtain the correct results. Lower heats may be used for water than for oil quenching.

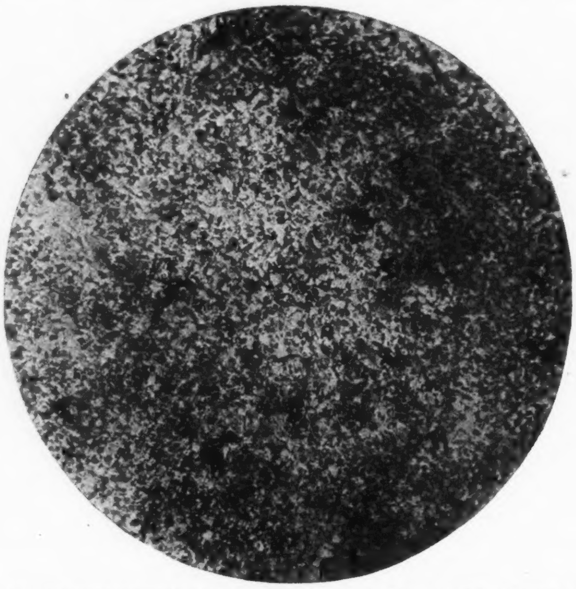


Fig. 9. Photomicrograph showing Grain Size of Core of Heat-treated Carburized Steel, containing 0.03 per cent Sulphur and Phosphorus. Magnification, 100

After the first heat the pieces should be washed in hot soda water to remove any oil, if they have been quenched in this medium. If the oil is allowed to remain on the surface it will bake on during the second heat and may cause soft spots on the case, as already mentioned. In the second heat the temperature to be used depends upon the same conditions already mentioned, namely, analysis and mass. In this case, however, the analysis is that of the case itself which, of course, is dependent upon two factors, the original analysis of the steel and the chemical content added by the carburizing compound. It is, therefore, obvious that two pieces from the same bar of steel, carburized by different methods, might require different heats for the refining of the case. A test specimen should be used to determine the heat giving the best results. A straight carbon steel of 1.00 per cent carbon content in the case will require a heat of from 760 degrees to 815 degrees C. (1400 degrees to 1500 degrees F.) depending upon its mass and the quenching medium used.

### Analysis of the Steel

The idea that any low carbon steel is satisfactory for carburizing is a fallacy which modern methods are disclosing, for there is no branch of the thermal treatment of steel where the exercise of skilled judgment, based on experience, will be more amply repaid. This is particularly true of carburizing processes carried out on a large scale, for here any non-uniformity in the analysis would result in non-uniformity in the product. The writer knows of instances where much time and labor were lost in fruitless attempts to perfect some method of refining the core of carburized steels very high in impurities. An analysis would have promptly indicated the trouble as due to the steel itself, and not to its treatment.

There are in use many different analyses, some based merely upon precedent, others upon scientific investigation, with a view to radical improvement. The latter are giving very promising results and show that the field is open to still further investigation. The carbon runs generally from about 0.08 to 0.25 per cent. As to what is the best content is not a subject for argument, but dependent entirely upon the nature of the parts and the purpose for which they are designed. Parts of very thin cross-section where the space allotted to case and core is of necessity small, should, if possible, be made of the lower carbon analysis, as greater toughness can then be obtained in the core which is otherwise

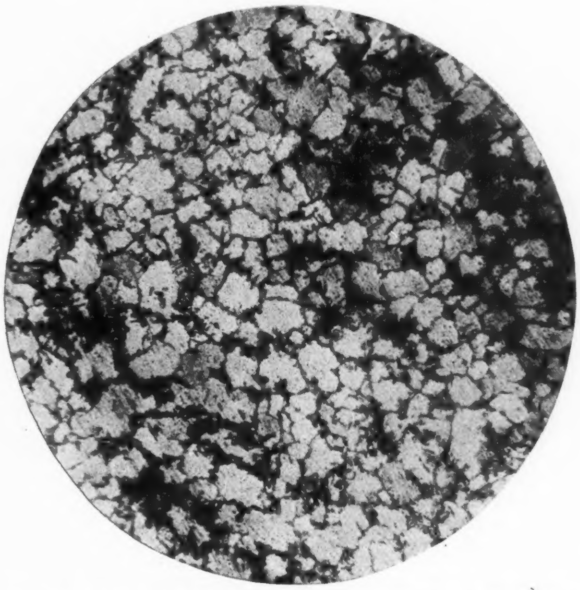


Fig. 10. Photomicrograph showing Grain Size of Core of Heat-treated Carburized Steel containing 0.06 per cent Sulphur. Magnification, 100

likely to be impaired in this respect, due to the case extending more or less into it.

If a tough core for any reason is absolutely essential in the highest degree, the lower carbon limit will obviously give the most satisfactory results. Where hardness is the most important consideration and the toughness of the core may to some extent be sacrificed, higher carbons around 0.20 per cent or more will give satisfaction. They should also be employed where it is essential that the pieces as a whole should possess considerable physical strength or where it is necessary that the case be firmly supported for excessive loads. In addition to straight carbon steels the low carbon alloy steels are employed. They add to the parts the same advantageous properties for which they are employed in other classes of steel.

Nickel is a valuable aid in producing a core which readily responds to refining and at considerably lower heats than in steel in which it is absent. In some cases results have been obtained by a single heat-treatment which compare most favorably with straight carbon steel, given two heats, one for case and one for core. The core resulting, has a fine grain and is extremely tough.

Chromium gives a very fine grain to case and core and imparts additional hardness in conjunction with the carbon. It has, however, when present much over 0.25 per cent, a tendency to render the core less tough, especially in steels around 0.20 per cent carbon, or higher.

Chrome-nickel steels containing both these elements give very fine results, with a judicious determination of their limits. They give very fine grained parts after heat-treatment and can be treated at a considerably lower temperature than straight carbon steels.

Phosphorus and sulphur are two impurities which are very detrimental to carburized steel if present in quantities in excess of 0.05 per cent. In good carburizing steels they should not exceed 0.04 per cent. This is very important, for it is quite frequently the cause of trouble experienced in refining the core and results in a very brittle article. Fig. 9 is a photomicrograph showing the grain size in the core of a carburized steel that has been given two treatments. The steel contained 0.03 per cent sulphur and phosphorus. Fig. 10 shows the grain size of a steel similarly treated, but containing 0.06 per cent sulphur. This steel possessed a very coarse and brittle core, as the photomicrograph clearly shows, while the former steel had a very fine tough core. Too much stress cannot be laid upon keeping these two impurities below 0.04 per cent. The manganese content may range from 0.30 to 0.80 per cent. The higher limits, however, tend to make a more brittle case. Silicon should be kept below 0.20 per cent.

In deciding upon the limits of analysis, care should be exercised to prevent too wide a variation in any of the constituents. Eight points in carbon is the widest variation permissible for uniform work on a large scale. Manganese should not vary over twenty points. No fixed rule can be given for the allowable variation of alloying elements, such as nickel, chrome, etc., as this depends upon the relative amounts of all the constituents present in the analysis.

Certain elements aid while others retard carburization—some in a very marked degree—and for this reason it is very essential that steels of different analysis be carefully kept separate. The following elements aid carburization: chromium, tungsten, molybdenum and manganese. The following retard carburization: nickel, aluminum, silicon and vanadium.

In conclusion, it may be observed that while considerable progress has of late been made in the art of carburizing, there still remains much to be done to place it upon as scientific and efficient a basis as are some of its related arts. The packing of the work by hand is crude, inefficient, and inexact and this is equally characteristic of some of the less important steps. In some of the more progressive concerns the articles are located in the pot by jigs and every mechanical convenience provided for accurate and efficient work in every particular. This practice is, however, the exception rather than the rule, but it is a step in the right direction, and shows that the opportunity for improvement has been realized.

* * *

An interesting use was made of moving pictures at the annual Graduates' Lecture delivered at the Institution of Mechanical Engineers (Great Britain). This year, Sir R. A. Hadfield delivered this lecture. Perhaps the most interesting part of it was the reference to armor plate and armor-piercing projectiles. This part of the lecture was illustrated by a moving picture display, the film being composed of a large number of drawings showing a projectile leaving the gun, striking the plate, the cap expanding and flying to pieces, and the projectile piercing the plate and exploding on the far side. The whole effect was excellent and care had been taken to produce a film built up from well-established facts. Although it was evident that the film was artificially produced, the presentation was very effective, as the series of drawings from which the film was made were carefully executed.

* * *

The quantity of iron ore mined in the United States in 1914 is estimated by Ernest F. Burchard of the United States Geological Survey to have been between 41,000,000 and 42,500,000 long tons. The average decrease in quantity mined by the fifty-two iron producing companies was 33 per cent compared with their output in 1913.

# TESTING LOCKE STEEL SPROCKET CHAIN

### FACILITIES PROVIDED IN THE LOCKE STEEL BELT COMPANY'S NEW FACTORY

BY EDWARD K. HAMMOND*

THE manufacture of Locke steel sprocket chains was described in detail in an article entitled "Chain-making Extraordinary in a Scrapless Press-room," by Chester L. Lucas, which was published in the November, 1909, number of MACHINERY. In this article it was pointed out that the conversion of strip steel stock into chain was accomplished without wasting any of the material in the form of scrap. After going through the new factory which the Locke Steel Belt Co. has recently built in Bridgeport, Conn., the visitor will be impressed by the fact that the elimination of waste has now been carried to a further point of refinement, not only by the exceptional factory facilities and method of handling the work, but in the careful checking up of the various manufacturing operations and a thorough testing of the finished product.

Fig. 1. Marquee over Office Entrance decorated with Conventionalized Design of Chain

The following are features of the factory which help to eliminate waste. The buildings are of concrete construction, making them absolutely fire-proof, and as a result, expenditures for fire insurance premiums are unnecessary. The walls of the main building, with the exception of space occupied by the columns, are given over to windows, so that an abundance of natural light is provided. This increases efficiency in manufacturing, and is also important on account of the fact that experience has shown good lighting to be a point of cardinal importance in testing and checking a product, and in the elimination of industrial accidents.

Further provision against accidents has been made by equipping all power presses in the factory with automatic feeds or Benjamin safeguards, and it is a noteworthy fact that the provisions which have been made for the safety of workmen have proven so effective that there has not been a single accident since work was started in the new factory. Both the main building in which the manufacturing is done, and the storage warehouse in which all material is received, have platforms on a siding from the main line of the New York, New Haven & Hartford R. R., so that the unloading of material and loading of product into cars can be handled at a minimum expense. The factory has been carefully laid out so that the material moves in a continuous circuit, thus simplifying the transfer of work from department to department.

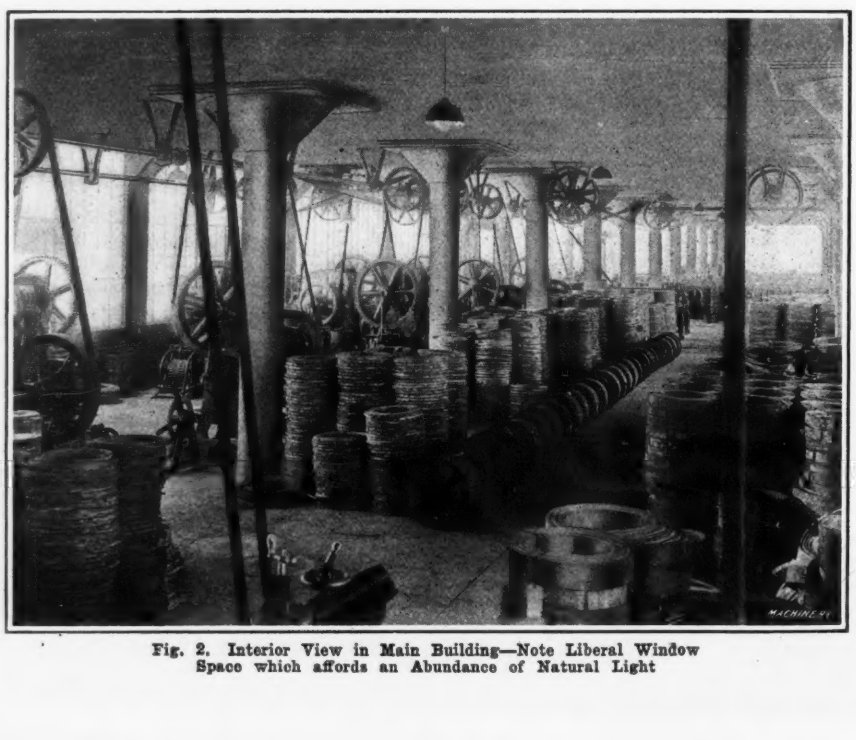


Fig. 2. Interior View in Main Building—Note Liberal Window Space which affords an Abundance of Natural Light

* Associate Editor of MACHINERY.

#### General Arrangement of the Plant

The plant of the Locke Steel Belt Co. is divided into four departments. It has already been mentioned that the buildings are of concrete construction. The offices of the company extend across the entire width of the main building at the front. The remainder of this building is divided into three bays which run down the entire length of the shop. The tool-room is located directly behind the office; then comes the press-room; the testing department and shipping room are located at the far end of the building. The most modern toilet facilities are provided in the basement of the main building.

The heat-treating department of the Locke Steel Belt Co. is housed in an individual concrete building which is equipped with oil-heated hardening furnaces, oil tempering baths, and the most modern form of instruments for determining and regulating temperatures. A third concrete building is provided for the storage of material, which is of ample capacity for reserve stocks. The fourth building is a small wooden structure in which the hot-rolled steel stock, from which the Locke chain is made, is "pickled" in sulphuric acid to remove the scale preparatory to sending the material to the press-room. The use of wood in the construction of this building is necessary as concrete would be rapidly damaged by the acid fumes.

#### Straightening the Steel

When stock comes to the press-room, the first step in this patented process of manufacture consists of straightening it edgewise ready to be fed into the dies. A special machine, shown in Fig. 4, has been built for this purpose, the design of which combines several interesting features. The principle on which it operates is the same as that of the commonly used type of flat straightener, in which the material is passed between a series of staggered rolls; but in the case of most flat straighteners, the different rolls are provided with means of making individual adjustment. In the machine which has been developed by the Locke Steel Belt Co. for straightening their steel stock, there are two sets of rolls—one for flat and the other for edge straightening—each set consisting of two rows of rolls. In each set, the position of one series or row of rolls is fixed, while the other row is

carried by an adjustable frame. In setting the machine, the position of the adjustable rolls is so regulated that the last roll just touches the stock which is to be straightened, without having any offset. The first roll is then adjusted toward the fixed rolls until the offset is sufficient for straightening the stock on which the machine is required to work. Thus, in passing through a set of straightening rolls, the bending of the stock is gradually decreased from the maximum offset to no offset whatever, and the stock comes out perfectly straight, in the plane in which a set of rolls has operated.

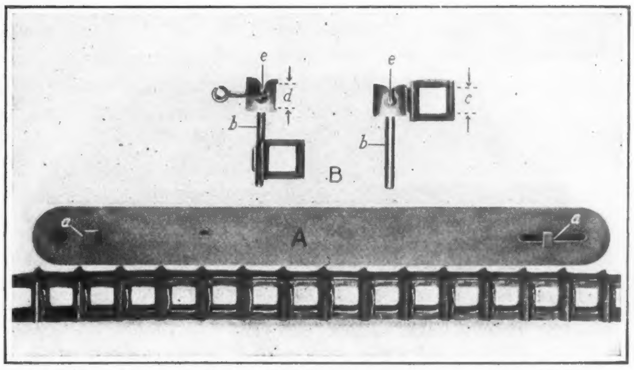



Fig. 3. Gages provided at Each Press for Use in testing Product at Frequent Intervals

The first set of rolls flattens the stock or straightens it flatwise, but has no effect sidewise. The stock then enters the second set of rolls which provides for straightening it edgewise. It has been mentioned that the machine is adaptable for straightening all sizes of stock used in making the company's product, and for the edge straightening operation it is necessary to adjust the center distance between the successive edge straightening rolls of each row to fourteen times the width of the stock which is being straightened. For this purpose, means are provided for changing the steps of both the fixed and adjustable rolls along the bed of the machine in order to give the required distance between centers. Experience has shown that with this setting the stock will come out of the machine perfectly straight, while if the center-distance between adjacent rolls were less than fourteen times the width of the stock, the strain would be so great that the edges of the stock would be upset, making it unfit for use in chain making, and a very large amount of power would be consumed.

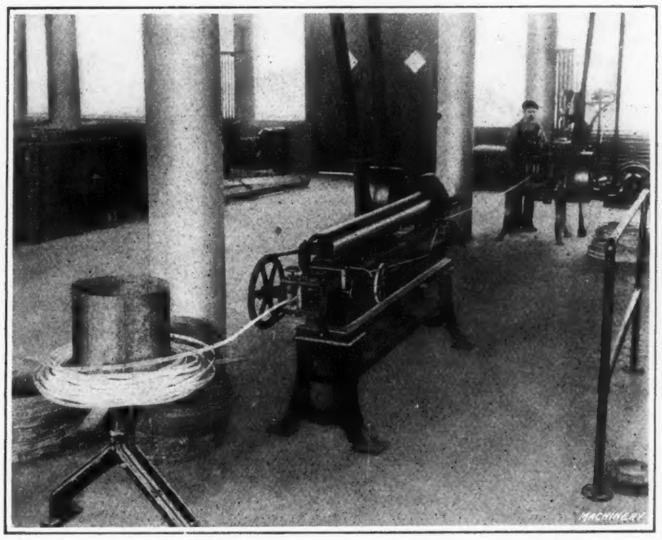


Fig. 4. Patented Straightening Machine designed for Use on Flat Stock

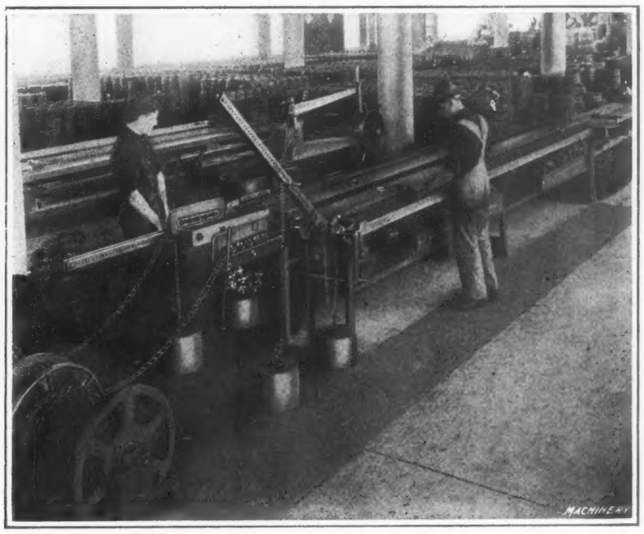


Fig. 5. Machines on which Every Link is tested and inspected

### Testing the Finished Chain

All of the chain made in the factory is subjected to a careful test which will disclose any weakness due to inherent defects in the steel or damage resulting from irregularities in the fabrication of the steel into finished chain. Gages of the form shown at *A* and *B* in Fig. 3 are provided for each press, and at frequent intervals the operator is required to use the gage *A* for testing the accuracy of the length of the chain, and gage *B* for determining the correct size of individual links. In using gage *A*, the chain is slipped over the studs *a*, so that the links are held by the gaging surfaces. The distance between these is the correct length for a given number of links and by frequent use of this gage by the press hand, the pitch of the chain is checked up as it is made, thus enabling a high degree of accuracy to be maintained. Gage *B* provides for making four different measurements on the links. The pin *b* is of the correct size for the loop on the link, the width of the head of the gage is the proper width *c* for the opening in the link, the groove *d* is the proper width for the hook of the link, and the groove *e* is the proper size for the round of the link which fits through the loop in the adjacent link. The gages *A* and *B* can be used very rapidly to make the five measurements which have been referred to, and their constant use guards against the possibility of producing any appreciable amount of defective chain before the error is discovered by the power press operator.

After the chain has been heat-treated, and before it is ready for shipment, it is tested on the machine shown in Fig. 5. On this machine 10-foot lengths of chain are loaded almost to the elastic limit of the material, and if there are any weak links, they will fail under this test. The test is conducted by hooking one end of the 10-foot strand of chain over a stud on the table and then attaching the opposite end to a hook on the weight lever. The weights are then applied to the chain in order to determine its reliability.

Fig. 6. Machine on which Last Two Links from Each Coil are tested to Destruction to determine Ultimate Strength

In the article previously published in MACHINERY, which described the manufacture of the chain, it was mentioned that a coil of strip steel was fed through the die from one side and that a coil of completely finished chain, made from this material, was automatically wound up on a reel at the opposite side of the press.

The tests of the chain described in the preceding paragraph give a fair degree of assurance that it is up to standard, but to make assurance doubly sure, two links of the chain from the ends of each coil of steel are taken to the machine shown in Fig. 6, where their ultimate strength is determined by loading the links until they break. For this purpose one link is secured to a hook held by the frame of the machine, while the other link is gripped by a hook carried on the weight beam. This beam is graduated like the beam of an ordinary weighing scale, and after the links have been set up on the machine the weight is run out on the beam until one of the links breaks. In this way the ultimate strength of the link is determined. The way in which the links break also indicates whether the strip of steel was of good quality or the heat-treatment of the chain was done in a satisfactory manner, *i. e.*, whether the steel in the finished chain has been brought to the proper condition, or if it is too hard or too soft. Experience has shown that if any variation occurs in the condition of chain made from the same coil of stock, the weakest links will be found in those sections of the chain made from the metal at either end of the coil, so that this test gives the minimum ultimate strength of the chain produced from each coil. The form shown in Fig. 7 is kept by the testing department in recording the results of the test of all chain made in the factory.

CHAIN TESTED

DATE May 8-1915

| SIZE | Press | Check | Heat | Coils | FEET | TEST | Quality |
|---|---|---|---|---|---|---|---|
| 25 | 3 | 13 | 4159 | 12 | 2198 | 900 | |
| 25 | 3 | 14 | 4159 | 11 | 2190 | 900 | |
| 32 | 4 | 3 | 122 | 8 | 1570 | 1400 | |
| 34 | 5 | 8 | 4144 | 6 | 1580 | 1500 | |
| 42 | 6 | 5 | 123 | 5 | 875 | 2000 | |
| 42 | 6 | 6 | 123 | 5 | 869 | 2000 | |
| 55 | 7 | 1 | 4162 | 4 | 780 | 3000 | |
| 55 | 7 | 2 | 4162 | 4 | 792 | 3000 | |
| 52 | 8 | 4 | 119 | 4 | 800 | 2800 | |
| 62 | 13 | 3 | 4175 | 4 | 496 | 4000 | |
| 62 | 13 | 4 | 4175 | 4 | 482 | 4000 | |
| 62 | 13 | 5 | 4175 | 4 | 489 | 4000 | |
| D | 14 | 1 | 900 | 4 | 378 | 5000 | |
| D | 14 | 2 | 900 | 5 | 348 | 5000 | |
| D | 14 | 3 | 900 | 4 | 346 | 5000 | |
| D | 14 | 4 | 900 | 4 | 371 | 5000 | |
| D | 14 | 5 | 900 | 5 | 370 | 5000 | |
| D | 14 | 6 | 900 | 4 | 379 | 5000 | |
| M | 16 | 21 | 365 | 4 | 302 | 5000 | |
| M | 16 | 22 | 365 | 4 | 392 | 5000 | |
| M | 16 | 23 | 365 | 5 | 395 | 5000 | |
| M | 16 | 24 | 365 | 4 | 390 | 5000 | |
| M | 16 | 25 | 365 | 5 | 397 | 5000 | |
| M | 16 | 26 | 365 | 4 | 396 | 5000 | |
| 88 | 18 | 37 | 207 | 3 | 274 | 6000 | |
| 88 | 18 | 38 | 207 | 3 | 275 | 6000 | |
| 88 | 18 | 39 | 207 | 3 | 278 | 6000 | |
| 88 | 18 | 40 | 207 | 3 | 279 | 6000 | |

Fig. 7. Form used by Inspection Department in recording Results of Tests

In keeping up the quality of the product, the expedient has been adopted of holding each workman responsible for the quality of his own product. For this purpose, a careful record is kept which shows the press on which each lot of chain was made, the workman who operated the press and the date on which the work was done. For the purpose of keeping this data, tags are employed which have the forms shown in Figs. 8 and 9, printed on opposite sides, on which the necessary information is recorded. These tags are tied onto the reels of chain as they go from department to department, and when the chain is finished, the information on the tags is copied off onto forms shown in Fig. 10, which are preserved in the office for future reference. By referring to this form, it will be seen that each coil of steel is given the steelmaker's "heat number," and when a lot of steel from a new "heat" is received at the factory, several of the coils are immediately sent to the press-room and made into chain, so that tests may be conducted to be sure that the steel is satisfactory before the shipment is accepted. In order to run this "test chain" through the factory as quickly as possible and to accumulate all necessary data, a tag of the form shown in Figs. 8 and 9 is attached to the reel, but the tag used for this purpose is red, while the ordinary tags are white. The red tag indicates that the chain on the reel is to be passed along as rapidly as possible, and observed closely for proper temperatures of heat-treatment, etc.

TESTED May 8 1915 BY M. Natale

| CHS. | LKS. | FEET | TEST | QUALITY |
|---|---|---|---|---|
| 250 | 40 | | 900 | O.K |
| | | 1447 | 900 | O.K |

PRESS 3 CHECK 13 HEAT 4159

CHAIN 25 STANDARD Silver

| MADE | COILS | PRESS HAND |
|---|---|---|
| May 6 | 12 | J. Gonal |
| HARDENED May 7 | | |
| FURNACE #1 | | |

Figs. 8 and 9. Forms printed on Tags used for recording Each Step in Process of Manufacture

Heat No. 4159 Invoice Mar. 18 1915 From Whom

C 35 M 56

Size 25 Rec'd Mar. 25 1915 Coils 1156 Lbs. 46,320 P 011 S 031

| MADE Date | Press | Coils | Chain No. | Press Hand | HARDENED Date | Date | TESTED Good Feet | Good S.L. | Hard Feet | Hard S.L. | Soft Feet | Soft S.L. | Make Feet | Make S.L. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mar. 30 '15 | 3 | 11 | 1 | J. Gonal | Mar. 31 | Apr. 1 | 2200 | 900 | | | | | | |
| Apr. 1 '15 | " | 11 | 2 | " | Apr. 2 | " 3 | 2182 | 900 | | | | | | |
| " 5 | " | 11 | 3 | " | " 6 | " 7 | 2190 | 900 | | | | | | |
| " 8 | " | 11 | 4 | " | " 9 | " 10 | 2210 | 900 | | | | | | |
| " 12 | " | 11 | 5 | " | " 13 | " 14 | 2186 | 900 | | | | | | |
| " 14 | " | 11 | 6 | " | " 15 | " 16 | 2184 | 900 | | | | | | |
| " 16 | " | 12 | 7 | " | " 17 | " 19 | 2202 | 900 | | | | | | |
| " 20 | " | 12 | 8 | " | " 21 | " 22 | 2194 | 900 | | | | | | |
| " 22 | " | 12 | 9 | " | " 23 | " 24 | 2189 | 900 | | | | | | |
| " 26 | " | 11 | 10 | " | " 27 | " 28 | 2204 | 900 | | | | | | |
| " 28 | " | 12 | 11 | " | " 29 | " 30 | 2183 | 900 | | | | | | |
| May 4 | " | 11 | 12 | " | May 5 | May 6 | 2201 | 900 | | | | | | |
| " 6 | " | 12 | 13 | " | " 7 | " 8 | 2198 | 900 | | | | | | |
| " 11 | " | 11 | 14 | " | " " | " 11 | 2190 | 900 | | | | | | |

Fig. 10. Form used by Office in keeping a Record of Every Chain made in the Locke Factory

### Determining the Power Capacity of Different Sizes of Chain

Fig. 11 shows a special form of dynamometer built by the Locke Steel Belt Co. for use in determining the wearing qualities and power transmitting capacities of different sizes of chain of its manufacture, when running at various speeds. It will be seen that this equipment consists of a pair of sprockets over which the chain is run. Instead of a prony brake to apply the load, the shaft which carries the driven sprocket is belted to an electric generator. The current developed is delivered to a series of arc lamps, the required number of which may be connected to the circuit; and incandescent lights are provided for making finer adjustments for the power consumption. An ammeter and a voltmoter are connected into the circuit, and from the readings of these instruments the number of kilowatt of power developed by the generator can be readily calculated. As 1 horsepower is equivalent to 0.746 kilowatt, the power developed by the generator—and hence the

power transmitted by the chain—may be easily converted into horsepower. This test also affords a means of determining the pull on the chain in transmitting power at various speeds. We know that 1 horsepower is equivalent to 33,000 foot-pounds per minute. Hence, by multiplying the number of horsepower transmitted by 33,000, and then dividing the speed of the chain in feet per minute, we obtain the pull in pounds.

There is a commonly quoted proverb that a chain is no stronger than its weakest link. The rigid tests to which all of the chain made by the Locke Steel Belt Co. is subjected, both during the process of manufacture and after completion, is the means of producing a chain of great uniformity with any chance weak link eliminated. As a result, advantage is taken of the full strength of the steel and there is practically no danger of a chain giving trouble when it is used for service of the character for which it is intended.

* * *

## RECENT LEGAL DECISIONS INVOLVING MACHINERY

### Grant of Patent Equivalent to Sale

(Federal.) A grant, for a fixed royalty paid in advance, of the right to use a patented machine during the full term of the patent, when it is to become the property of the licensee if he has observed the terms of the license, is equivalent to a "sale," and the owner of the patent, having received full payment of the price, fixed by himself, cannot by a provision of the license, restrict the right of the licensee to transfer the same for whatever consideration he may see fit. This is so, even though the patentee still has the right under its form of license to require the transferee to purchase from itself certain things adapted for use with the patented machine. *(National Malleable Castings Co. v. T. H. Symington Co., 222 Fed. 523.)*

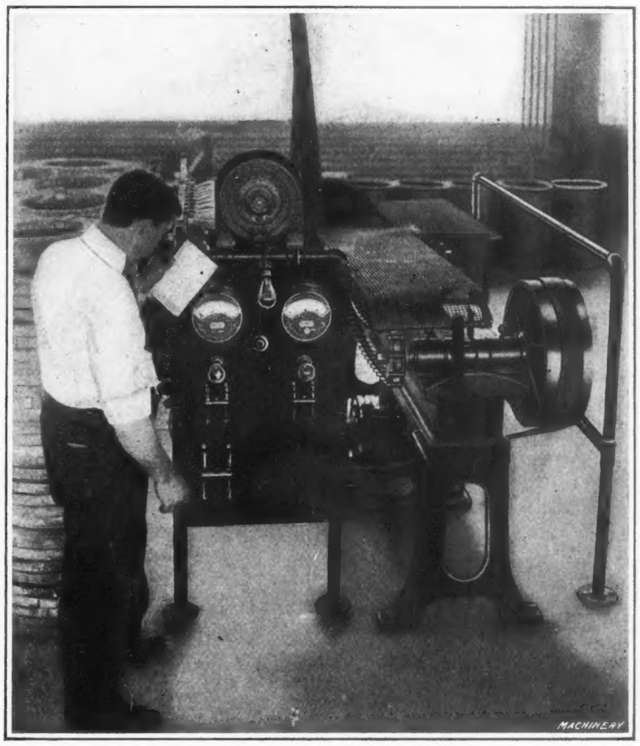


Fig. 11. Special Dynamometer used to determine Comparative Work and Wear under Actual Running Tests

### Notice to Cancel Purchase Contract May be Oral

(New York.) Where a contract of sale provided that, if the defendant could purchase elsewhere a similar machine better suited to his requirements, its contract with plaintiff "should expire thirty days after notice of such possibility shall be served," the provision requiring notice could be satisfied either by an oral or written notice; the use of the word "served" not necessarily implying a writing. *(Lang v. Lux Mfg. Co., 153 N. Y. S. 292.)*

### Waiver of Breach of Warranty

(New York.) Where, in an action for machinery sold and delivered, a reasonable time has elapsed after delivery to enable the buyer to examine the machinery, and to reject it if not conforming to sample, a failure to return or offer to return the machinery within such time, constituted a waiver of breach of warranty as a defense. *(Silberstein v. Blum, 153 N. Y. S. 34.)*

### Liability of Manufacturer for Sale of Dangerous Machinery

(New York.) A manufacturer of automobiles, who constructs a hand brake on an automobile of inferior materials and who improperly assembles the parts of the car, is liable to a purchaser of the car from the manufacturer's agent, who had purchased it from the manufacturer, for injuries to the car, caused by the defective equipment and negligent assembling. *(Quackenbush v. Ford Motor Co., 153 N. Y. S. 131.)*

### Verbal Warranty of Machine not Admissible as Evidence

(Michigan.) In the trial of an action for the price of a machine sold to defendant, wherein defendant gave notice that it would show that plaintiff, to induce the purchase of the machine, fraudulently represented that its installation would save over $3,000 a year, such representation did not amount to a false representation, but only to a verbal warranty, inadmissible as evidence to vary the terms of the written contract of sale. A buyer who kept a machine and continued to use it down to the trial of the seller's action for the price was estopped to claim a rescission of the contract as a defense. *(Linderman Mach. Co. v. Shaw-Walker Co., 153 N. W. 34.)*

### Not Entitled to Allowance

(Kentucky.) In an action for the balance due on the purchase price of certain machinery which the buyer had used for two years, during which time he had made payments and had renewed his notes for the balance, though complaining of defects, he is not entitled to an allowance for such defects. He should not have made payments until the defects were remedied. *(Oman-Bowling Green Stone Co. v. Sullivan Machinery Co., 176 S. W. 973.)*

### Not Entitled to Warning that Machinery Was Dangerous

(Missouri.) Plaintiff, who had worked about a baling machine, and was familiar with it, and to whom the danger of putting his hand into it while it was moving was obvious, although the machine moved slowly, and could be readily and quickly stopped by a lever, was not entitled to any warning of such danger which was merely incidental to the service; although, where the danger is an extraordinary one, that is, not ordinarily incident to the service, and the master has knowledge thereof, failure to warn the servant of such danger would be negligence.

In such case the foreman's direction to plaintiff to operate the machine with the lid raised was not actionable negligence, where the lid was not designed to protect the servant from the danger of injury by putting his hands into the machine when in operation, and where the defendant could not have reasonably anticipated that to operate the machine with the lid raised would occasion the injury, which could not have occurred otherwise than by unnecessary exposure to danger, since the master is not an insurer of the servant's safety, and if the method adopted, though not the safest, is a reasonably safe one, is not liable for having adopted such method. *(Piorkowski v. A. Leschen & Sons Rope Co., 176 S. W. 259.)*

### County Liable for Value of Machinery

(Texas.) A manufacturer of machinery selling one of its machines to a county agent not knowing him to be such agent, and discovering the fact may call upon the county for payment of the machine especially where the county has benefitted by the use of the machine. *(Dallam County v. S. H. Supply Co., 176 S. W. 799.)*

* * *

As a quenching medium for hardening, mineral oils are generally more effective than fish and cotton-seed oils, which latter for a long time have been looked upon as the best oil for quenching purposes. A mineral oil having a specific gravity of 0.86, a flash point of 420 degrees F., a flash point of 420 degrees F., a viscosity of 170 seconds at 100 degrees F., as shown by the Saybold viscosimeter, gives good results and can be bought cheaply.

# THE HEAT-TREATMENT AND TESTING OF SHRAPNEL SHELLS*

## RECORD OF THOROUGH SHOP TESTS TO SECURE DATA FOR HEAT-TREATMENT

BY J. M. WILSON†

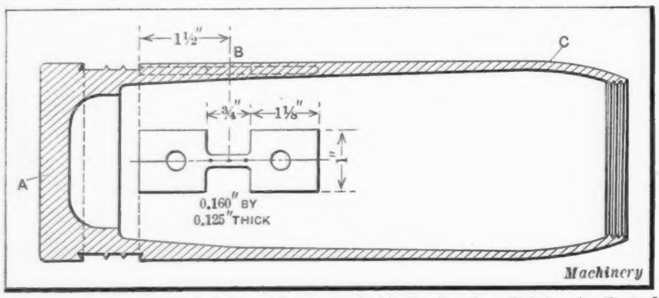



Fig. 1. Cross-sectional View of Shrapnel Shell showing Points A, B and C where Tests are made, and one of the Tensile Test Samples

WHILE most Canadian manufacturers have overcome the difficulties which are now more or less to be expected in taking up the manufacture of such a special and unusual article as shrapnel shells, many of the firms are still ex-experiencing some trouble in heat-treating the shells to enable them to fulfill the requirements of government specifications. The object in heat-treating shells is to give the forgings a minimum strength which will enable them to resist firing strains at certain points. The manner in which these strains arise and the condition of the steel necessary to meet them should be clearly understood by all those who have any responsibility in the heat-treatment of shells, as it is possible to have good and bad shells and still meet government specifications. The writer of this article has been actively engaged in treating shells since the beginning of the war, and had to rely entirely upon his own resources in meeting and overcoming the troubles which seemed to arise on all sides, causing manufacturers serious, and by no means unfounded, alarm as to the ultimate success of their efforts.

The government shell specifications call for a yield point or elastic limit, after heat-treating, of not less than 36 tons per square inch, a breaking point or ultimate strength of not less than 56 tons per square inch, and an elongation of not less than 8 per cent in ⅝ inch. Officially there is no maximum specified for either of those three physical characteristics; but as a matter of fact any unusual condition which is not in conformity with recognized metallurgical practice may cause the chief government inspector for the district in which the manufacturer is located to reject a shipment. Reference has been made to certain points in the shell which must resist the strains due to firing. The nature of these strains and condition of the steel best suited to meet them will be understood from Fig. 1, which shows a cross-section of the British 18-pound shrapnel shell. When a shell is fired from a gun, the base *A* is subjected to a blow, *i. e.*, a sudden increase of pressure which almost instantly attains a maximum of 12 to 14 tons per square inch, and imparts the initial velocity to the shell. The shell, being a body at rest, opposes this velocity with its own inertia, the result being that both compressive and tensile strains are set up in the shell body. The shell body assumes the conditions of a column which has a compressive load varying from nothing at the nose, to a maximum at the base. The tensile load is due to the inertia of the bullets inside the shell. These bullets are subject to an increasing compressive load from the top down, the resultant strain being a bursting effort which attains a maximum in the region of the point *B* known as the "set-up point."

TABLE I. RESULTS OF TESTS TO DETERMINE THE BEST QUENCHING MEDIUM FOR SHRAPNEL SHELLS

| Quenching temperature, degrees F. | Quenching medium | Temperature of quenching medium, degrees F. | Scleroscope hardness No. |
|---|---|---|---|
| 1475 | Fish oil...... | 90 | 50 to 55 |
| 1475 | Coal oil...... | 90 | 65 to 70 |
| 1475 | Cottonseed oil | 90 | 70 to 75 |
| 1475 | Engine oil... | 90 | 75 to 80 |
| 1475 | Oil of degras. | 90 | 77 to 85 |
| 1475 | Water ....... | 90 | 82 to 87 |

*Machinery*

When the time required for the fuse to act has elapsed, the powder charge is exploded, and the contents of the shell are blown forward in the usual manner. The contents are released either by the stripping of the thread of the brass socket, or else the walls of the shell yield at the point *C*, opening the threads sufficiently to free the socket. At *A*, (the base) the shell must be perfectly sound and free from flaws such as minute cracks, etc., which may allow the flame from the firing charge to strike through with disastrous results to the shell and gun. The metal in the base must not be too hard or it may fracture under the pressure of the explosion, and it must not be too soft or it may flatten out and spoil the rifling in the bore. At the point *B* there is no maximum requirement so far as tensile strength is concerned, but any abnormal strength is viewed with suspicion unless it is accompanied by a generous elongation. At *B* the metal is particularly liable to distension while the shell is acquiring velocity, and unless the shell is strong enough to resist the sudden bursting strain, and the amount of elongation is sufficient to cushion or absorb this strain at the instant of firing, the shell is liable to take a permanent set in the region of point *B*, with results mentioned above. The shell must not be too hard at the point *C* as it may burst, thus neutralizing the real object of a shrapnel shell which is to project the bullets forward with increased velocity at the predetermined instant, being in fact an aerial gun arranged to discharge its contents at any desired point of its flight. The favorite expression of newspaper correspondents, "a fragment of shrapnel," would therefore indicate a prevalence of defective shells so far as the enemy is concerned.

TABLE II. RESULTS OF TESTS CONDUCTED TO SECURE GENERAL DATA ON HEAT-TREATMENT

| Heat No. | 1 | 2 | 3 |
|---|---|---|---|
| Carbon, per cent...... | 0.45 | 0.52 | 0.50 |
| Manganese, per cent.. | 0.68 | 0.62 | 0.47 |
| Decalescent point, degrees F............. | 1400 | 1425 | 1390 |
| Quenching temperature, degrees F..... | 1450 | 1475 | 1450 |
| Temperature of oil, degrees F........... | 160 | 160 | 120 |
| Resultant hardness, scleroscope No....... | 65 to 75 | 65 to 75 | *39 |
| Temperature of water, degrees F........... | .... | .... | 75 |
| Resultant hardness, scleroscope No....... | .... | .... | 55 to 60 |
| Tempered until showing a scleroscope hardness of......... | 48 | 48 | 52 |
| Yield point, tons...... | 47.8 | 48.6 | 46.5 |
| Breaking point, tons.. | 67.9 | 65.4 | 66.2 |
| Elongation, per cent.. | 14.5 | 16.9 | 17.4 |

*Machinery*

* Note: This shell was then reheated and quenched in water with results shown

* For other articles on the manufacture of shrapnel published in MACHINERY, see "Shrapnel and Shrapnel Manufacture" by Douglas T. Hamilton, April, 1915; "Machining Shrapnel Shells, March, 1915; and other articles there referred to.

† Address: Metallurgist, Chapman Double Ball Bearing Co. of Canada, Ltd., 339-351 Sorauren Ave., Toronto, Canada.

Having gotten these requirements firmly established in his mind, the heat-treating expert is now confronted with a double problem: How is it possible to give steel the suitable strength; and having done so, how is it possible to know that the desired result has been obtained, without actually making test pieces from each shell. The principal condition upon which successful heat-treating depends is uniformity of material. Carbon and manganese are the principal substances which influence the results. The exact composition of steel specified by the government is not given to any manufacturers other than steelmakers. It is, however, generally understood to be a 0.50 per cent carbon, 0.60 per cent manganese steel. Allowing five points variation in carbon and 10 points variation in manganese, the requirements would be approximately 0.45 to 0.55 per cent carbon and 0.50 to 0.70 per cent manganese. In one carload of forgings, the author's firm received shells from 23 different heats or melts, with carbon varying from 0.60 to 0.47 per cent, and manganese varying from 0.63 to 0.49 per cent, with all possible combinations and proportions between these limits. The number of forgings supplied from each heat varied from one up to 1200 so that the question of determining the best temperature for each carbon content was indeed quite impracticable. Many manufacturers at the present moment may be in a similar position, and the gravity of the situation, both from a financial and a military point of view, may justify a somewhat detailed description of the method which was followed in treating shells of such varying composition.

It is generally known to manufacturers that the highest tensile strength of steel is obtained by cooling it rapidly from a temperature slightly higher than the decalescent point or critical temperature. The degree of hardness resulting from this operation can be ascertained quickly, accurately, and repeatedly by means of the scleroscope. The degree of hardness thus shown is a reliable indication of the probable strength of the material; that is to say, after making due allowance for different makes of steel and varying proportions of the principal constituents, the scleroscope readings are a reliable indication of the results which may be expected when a tensile test is made of any given shell. In the opening months of the shell business, considerable reliance was placed on the accurate determination of the decalescent point. Forgings of varying analysis were received; the carbon being from 0.48 to 0.53 per cent, and the manganese from 0.54 to 0.69 per cent. All steels whose composition was within those limits showed a decalescent point of between 1390 and 1425 degrees F., and when quenched in

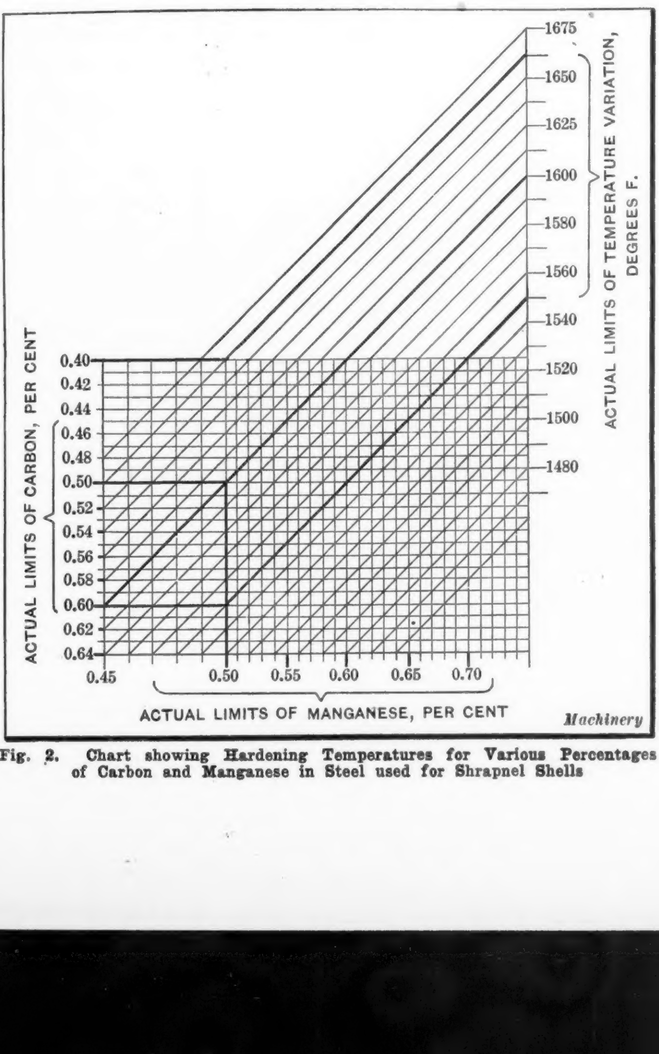



Fig. 2. Chart showing Hardening Temperatures for Various Percentages of Carbon and Manganese in Steel used for Shrapnel Shells

TABLE III. RESULTS OF TESTS ON SAMPLES TAKEN FROM A SHELL WITH A SCLEROSCOPE HARDNESS NO. OF 48 TO 52

| Heat No. | Scleroscope reading on test piece after machining | Yield point, tons | Breaking point, tons | Elongation, per cent |
|---|---|---|---|---|
| 1 | Outside 52—53—50<br>Inside 55—55—55 | 55.8 | 73.3 | 14.3 |
| 2 | Outside 52—54—50<br>Inside 55—57—53 | 53.8 | 72.4 | 17.4 |
| 8 | Outside 57—57—49<br>Inside 60—62—51 | 52.8 | 77.3 | 12.7 |

*Machinery*

water at 50 degrees F. above the decalescent point, such steels would have a scleroscope hardness number as high as 85; but when quenched in ordinary fish oil the hardness was only slightly over 50, the sample being 1 inch square and 1/8 inch thick. A complete shell quenched in fish oil would show a scleroscope hardness number at the set-up point of 38 to 40. Test pieces from such a shell failed to reach the minimum breaking strength of 56 tons by the narrow margin of 0.6 tons, and this failure brought up the question of which was the best quenching medium. A series of experiments gave the results presented in Table I; all conditions were equal in each test, and the test pieces were all made from the same forging.

From the results of the tests presented in Table I, oil of degras, commercially known as "No. 2 soluble quenching oil," was selected as the quenching medium and operations were commenced on forgings supplied from two separate heats. The results were all that could be desired until forgings were received from a certain heat, which would not respond to treatment based upon the results of preliminary experiments. Investigation yielded the results presented in Table II. While water-treatment of the forgings from Heat No. 3 gave satisfactory strengths under test, the liability of shells to crack, owing to their thin walls contracting more rapidly than the base, was a fatal objection to this method. Attention should be called to the fact that while the temperature at which quenching should be done is specified by the government at 1560 degrees F., manufacturers are not tied down to this particular temperature. What is required is that the manufacturers shall so treat the material that it will fulfill the requirements already stated. If while fulfilling the requirements, should the treatment prove detrimental to the shell in other respects, then it is time for the manufacturer to worry.

Referring to results presented in Table II, Heat No. 3, it will be observed that the manganese is only 0.47 per cent with carbon 0.50 per cent. Comparing Heat No. 3 with Heat No. 1, it is evident that an increase of 5 points carbon is more than offset by a reduction of 21 points in the manganese. Increase of temperature seemed to offer the greatest possibilities and sample shells were drawn every 12½ degrees up to 1675 degrees F. The greatest hardness was obtained at 1637½ scleroscope readings of 50 to 55 being the average. This was not considered satisfactory, and the oil-circulating pump was speeded up. Scleroscope readings as high as 65 were frequently obtained at a quenching temperature of approximately 1635 degrees, and when the shell was tempered to read 48 to 52 on the scleroscope, three test pieces from one shell gave the results presented in Table III. A careful study of this data revealed the fact that, while a low carbon, low manganese steel hardens satisfactorily within a very limited range of temperature, a medium steel has a wider range, and a high steel a still wider range of hardening temperature.

When the shipment of mixed heats previously referred to was treated, the method pursued was to take 0.50 per cent carbon and 0.50 per cent manganese as a base composition which hardened at 1600 degrees F. to show 55 to 65 hardness on the scleroscope. Then: (a) If, for every point of carbon below 50 there be present 1 or more points of manganese above 50, the steel should harden satisfactorily at 1600 degrees F. (b) If, for every point of manganese below 50 there

be present 2 or more points of carbon above 50, the steel should harden satisfactorily at 1600 degrees F. (c) If both carbon and manganese be below 0.50 per cent, increase the hardening temperature 12½ degrees F. for each point of manganese short of 50, and 6¼ degrees F. for each point of carbon short of 50. (d) If both carbon and manganese are above 0.50 per cent, a hardness number above 55 will probably be obtained at a quenching temperature of 1600 degrees F., but the maximum hardness, *i. e.*, 75 to 80 will be obtained at a somewhat lower temperature, the exact temperature being most easily found by starting at 1500 degrees F. and trying a couple of sample shells every 25 degrees F. until a maximum hardness is obtained. Forgings containing 0.50 to 0.55 per cent carbon and 0.54 to 0.62 per cent manganese in any varying proportions may be hardened at 1600 degrees F. to show a hardness number of 55 to 75; and when tempered to give a hardness number of from 48 to 52 they will yield the following results: yield point, 45 to 50 tons; breaking point, 65 to 70 tons; and elongation, 14 to 20 per cent.

Looking back, (c) offers a basis for charting the hardening points in a fairly approximate manner, to form a guide as to where the best hardness may be obtained. Such a chart is shown in Fig. 2. By following the horizontal and vertical lines from the carbon and manganese content until they intersect, a diagonal line will be found which will indicate the temperature at or about which the maximum hardness will be obtained. This does not prevent the use of 1600 degrees F. as the average temperature for the majority of shells, provided they are strong enough when hardened at that temperature; but where shells do not harden satisfactorily at 1600 degrees F., the chart offers an alternative method subject to such variation as may arise due to the use of steel from different makers, etc. The author's practice is to make careful scleroscope readings of each piece before pulling. Care must be taken to have a uniform surface on both sides, all tool marks being removed with fine emery cloth. The points tested are shown at *A*, *B* and *C* in Fig. 1. After the test piece is made, the value of the hardness number increases as a result of the piece being solidly supported in the scleroscope, whereas when the reading is made on the shell, the arched form of the wall acts as a spring, and absorbs the shock to some extent. Readings thus increase from 2 to 10 points after the test piece is finished.

A careful study of the data presented in Table IV reveals the fact that results are not always consistent. With an increase of carbon, one occasionally finds an increase in elongation and *vice versa;* and the results due to variations in manganese content are similarly unreliable. In order to secure a degree of uniformity in hardness, which will be sufficient to insure test pieces standing up successfully, it is necessary to have the shell hard inside as well as outside, and a method of doing this is referred to later. Assuming now that the shell has been tempered, it is rough-polished on a canvas buffing wheel around the outside of *B*, Fig. 1 for a width of at least 1 inch. Readings by the scleroscope are made on a zone ¾ inch wide and if they are between 46 and 52 the shell may be relied upon to show good results in the tensile test. In making test pieces, it is desirable to cut the piece from a spot which reads 48 to 50; and in machining the test piece, care should be taken to remove an equal quantity of metal from either side of the wall so that the test piece is a true specimen of the average wall structure. Where a shell is carelessly quenched, and the test piece so machined that the surface on one side is practically the same as the inner side of the wall, the results would not be a true indication of the real average strength, and a lot of shells might possibly be rejected on account of a slight oversight in this respect. Reference has been made to the base *A*, Fig. 1. Forging defects show up here occasionally and in such cases the shell is at once condemned. These flaws take the form of small cracks, from the width of a hair up to 1/16 inch. They seldom can be detected until after heat-treating, and are most easily observed by polishing the base on a disk grinder. Losses in this respect vary, but might average about 0.20 per cent. The hardness of the base itself may vary from 38 to 50, which insures an ample degree of toughness and avoids all possibility of the shell cracking under fire.

Many methods of heating, quenching, annealing and cleaning are in

TABLE IV. DATA ON THE HEAT-TREATMENT AND STRENGTH TESTS OF SHRAPNEL SHELLS

| Carbon, per cent | Manganese, per cent | Quenching temperature, degrees F. | Tempered, scleroscope hardness No. | Readings of scleroscope | Yield point, tons | Breaking point, tons | Elongation, per cent |
|---|---|---|---|---|---|---|---|
| 0.50 | 0.47 | 1635 | 51 | 60—57—57<br>47—48—48 | 48.3 | 69.9 | 16.9 |
| Three pieces from one shell | | | | 60—56—53<br>48—52—58 | 45.2 | 70.6 | 19.1 |
| | | | | 63—56—57<br>51—55—54 | 51.6 | 74.6 | 16.9 |
| 0.48 | 0.65 | 1565 | 49 | 51—54—52<br>48—53—50 | 47.3 | 67.4 | 15.9 |
| Three pieces from one shell | | | | 51—52—49<br>53—51—51 | 48.2 | 67.9 | 15.3 |
| | | | | 52—55—50<br>50—55—47 | 49.2 | 70.7 | 15.4 |
| 0.50 | 0.57 | 1600 | 50 | 50—52—50<br>49—50—49 | 46.0 | 64.8 | 19.0 |
| 0.50 | 0.57 | 1600 | 50 | 56—60—57<br>54—56—54 | 55.8 | 77.8 | 14.3 |
| 0.50 | 0.57 | 1600 | 50 | 59—60—56<br>55—59+56 | 60.7 | 82.2 | 12.7 |
| 0.60 | 0.57 | 1600 | 50 | 60—61—55<br>60—62—57 | 57.8 | 80.0 | 12.6 |
| 0.60 | 0.57 | 1600 | 52 | 57—57—56<br>54—56—53 | 48.2 | 69.7 | 17.5 |
| 0.50 | 0.57 | 1600 | 50 | 48—52—50<br>49—52—49 | 44.2 | 64.3 | 17.4 |
| 0.50 | 0.57 | 1600 | 50 | 52—55—55<br>50—51—52 | 44.7 | 65.2 | 14.7 |

*Machinery*

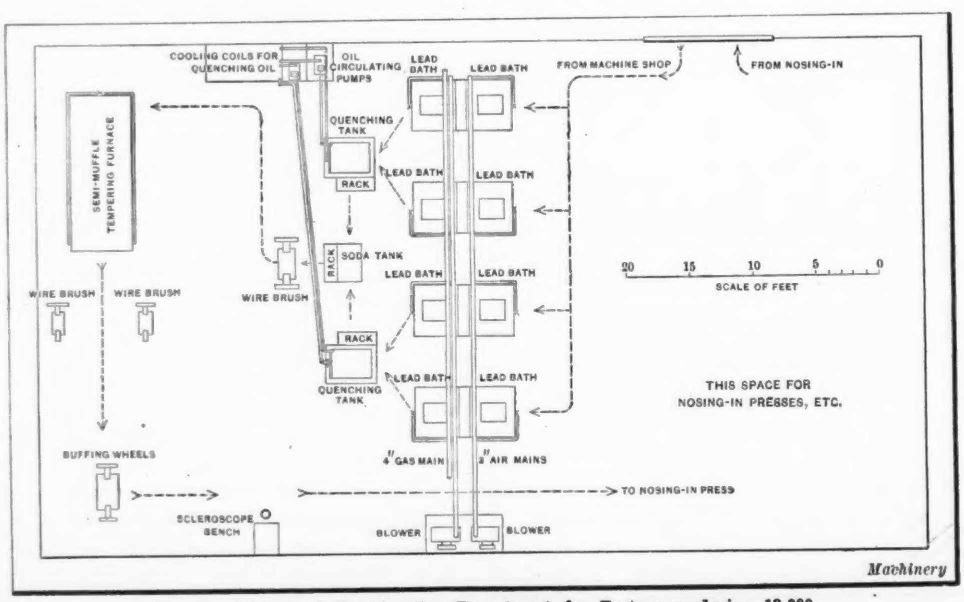



**Fig. 3. Layout of Heat-treating Department for Factory producing 12,000 to 15,000 Shrapnel Shells a Week**

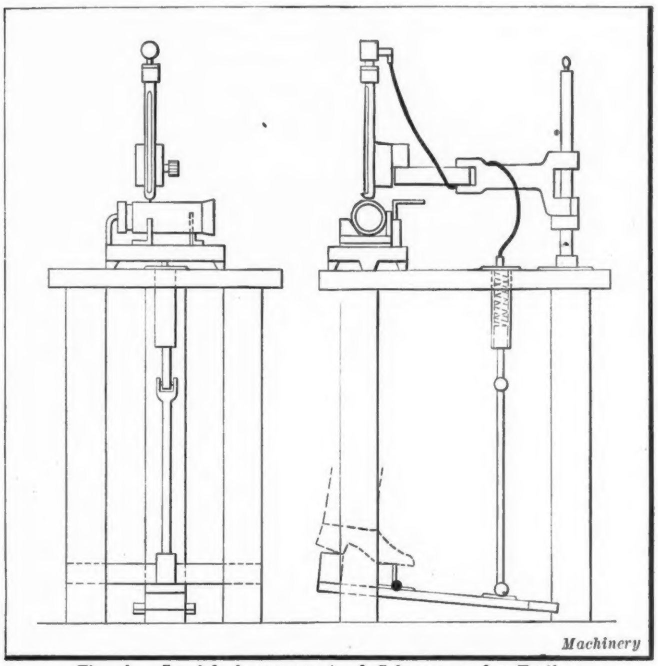



Fig. 4. Special Arrangement of Scleroscope for Testing Shrapnel Shells

use by the different firms engaged in shell making. For rapidity of output, cleanliness of the resulting product, ease and economy of operation, and uniformity and control of results, the author is in favor of the lead bath for hardening, and semi-muffle furnace for annealing. In one case the use of a lead bath by a skilled operator yielded excellent results both as to economy and uniformity, but when the output exceeds 500 shells per 12 hours, a semi-continuous furnace meets the requirements to better advantage. The layout of a hardening room for an output of 12,000 shells per week is given in Fig. 3. The lead baths consist of a rectangular pot of suitable capacity, resting on a 4½-inch hearth built of common firebrick and heated by either oil or gas burners below the hearth. They are built in pairs with a common wall between, which is thick enough to provide a flue to carry off products of combustion. The quenching tanks are rectangular, water-jacketed, and provided with two quenching cradles each. These cradles are arranged to swing lengthwise in the tank and when the carrier holding the shell is lowered into the oil, a pipe is automatically extended downward into the shell and introduces cold oil in the inside of the shell, while the operator swings the cradle back and forth in the tank, thus cooling the outside of the shell at the same time. This method of quenching has enabled the writer to harden shells which, by reason of low carbon and manganese, defied all conventional methods of dipping and swinging back and forth with tongs. The output per man with this apparatus is largely in excess of any hand method, while the uniformity and degree of hardness is all that could be desired.

The oil pump draws the oil from a depth of 6 inches below the surface and pumps it through 100 feet of 1-inch copper pipe arranged in two 50-foot coils in parallel. The cooled oil is delivered into an overhead reservoir, the overflow being connected to both tanks equally. After quenching, the shells are set on draining racks, and then washed in boiling-water and sal-soda, placed on another draining rack and then roughly brushed on wire brushes ready for tempering. The tempering furnace is of rectangular form, and consists of a long flat hearth with rails laid lengthwise on it. At each end a space is partitioned off from the body of the furnace, by means of vertical sliding doors; and a rack holding a number of shells is deposited on the rails at the front end of the hearth, the door is elevated and the rack is slid into the main chamber. After a suitable lapse of time another rack is introduced, and so on until the first rack is ejected at the rear end of the furnace. The shells are now hot enough to loosen all foreign matter on the surface, and a few seconds brushing with a wire brush cleans out the driving band groove, and leaves the shell with a delicate brown oxidized finish. The shell is now spotted on three places with a canvas buff and tested for hardness on the scleroscope. Fig. 4 shows the arrangement of the scleroscope as used by the writer. The shell is supported on a single narrow V-block with hardened edges, situated immediately under the set-up point. A narrow strip supports the open end of the shell, thus giving a three-point support, while a vertical stop at the back of the shell maintains it in a position tangential to the radius of the swinging arm. The usual rubber bulb was soon dispensed with as being quite unsuited for such hard service, and a small pump cylinder substituted. The piston in the cylinder is operated by a downward pressure of the heel on the pedal to give compression, and a spring inside the cylinder gives the necessary pull when the scleroscope hammer is to be raised by suction. After being tested the shells are ready for "nosing in."

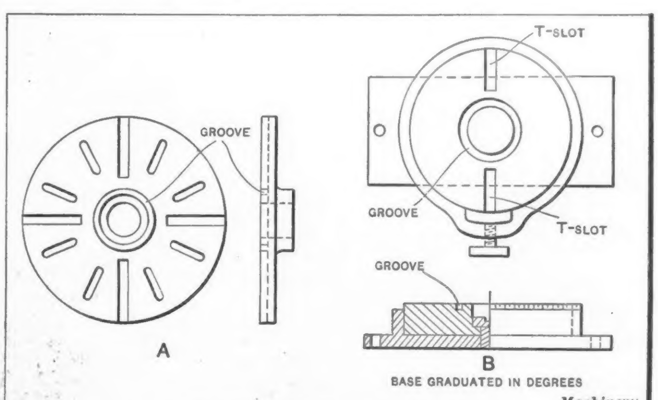
* * *

## STANDARD JIG FASTENING

BY CHARLES C. ANTHONY*

In shops where a great many jigs are used, confusion is bound to occur if some uniform system is not adopted for securing the jigs to the machines on which they are to be used. In some cases the jig is put on the faceplate of a lathe or other machine for which it is intended, the correct position determined, and the jig is then bolted in place. Obviously where such a course is followed, the setting up of a machine takes a lot of unnecessary time. To overcome this difficulty, some shops resort to the practice of drilling dowel-pin holes, but where this is done for a number of different jigs, the operator is frequently in doubt as to which holes belong to the particular jig which he is setting up.

In order to enable any jig to be used on any lathe, the writer adopted the following method. A narrow circular groove 4 inches in diameter by about ⅛ inch in depth was turned in the faceplate of each lathe, as shown at *A*, and all jigs were made with a ring of the proper dimensions to enter this groove. In this way all jigs are interchangeable between different machines and there is no loss of time in setting up. For use on milling machines, shapers, planers and other machine tools on which jigs and fixtures are employed, a similar method has been adopted, except that a graduated base *B* is made; the circular groove is cut in this base and the base is clamped to the table of the machine in the usual way. A feature of this method is that any jig can be set up on any machine which is idle, so that loss of time which would otherwise result through waiting for a given machine is avoided. Old jigs and fixtures can be adapted to this system by turning a groove in the base of the fixture, and then fitting a ring into this groove, which is of the proper size to enter the circular groove in the faceplate or graduated base which supports the fixture. The method has proved a valuable one, and may interest other mechanics who have met with the same difficulties as the writer. It increases the efficiency of the shop.




Interchangeable Method of fastening Jigs and Fixtures to Machines

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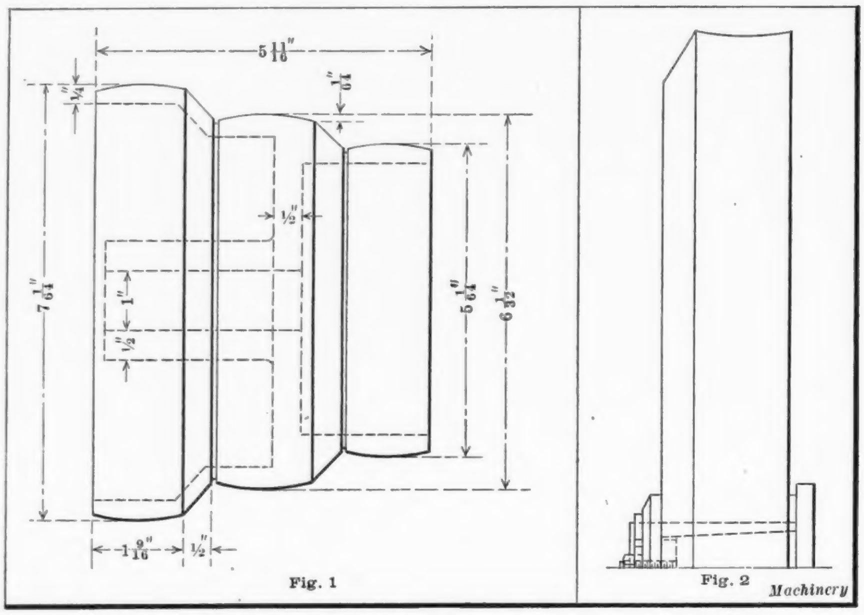
# GRINDING CONE PULLEYS AT THE NORTON PLANT*

BY HARRY W. AULT†

It is the purpose of this article to describe the grinding of three-step cast-iron cone pulleys of the form shown in Fig. 1, and also to explain the use of the attachment employed for truing the grinding wheels to the shape illustrated in Fig. 2. Probably the best way to give the reader an idea of the condition in which the work comes to the grinding machine will be to briefly describe the roughing operations performed on the crown and bevel of the pulleys. The pulley castings come to the factory in lots of 200 and are drilled and reamed, have the inside turned and the hub turned and faced; in addition, the pulleys are faced on each end.



Figs. 1 and 2. One of the Cone Pulleys to be ground; and Wheel for grinding Crown and Beveled Face simultaneously

After these operations have been performed, the work is taken to a 16-inch Reed engine lathe, which is equipped with a forming attachment for roughing-out the crown on the pulleys. A gang tool is used for this operation so that cuts may be taken over each of the three steps. The rate of production is 100 pulleys in a ten-hour day. The next operation consists of turning the bevel between the steps on the pulleys. A gang tool is also employed for this work, which is done on the same lathe that was employed for forming the crowns. On the bevel turning operation, the rate of production is 150 pulleys per day. After completing this operation the pulleys are ready for grinding.

For the grinding operation, a 10-inch Norton plain grinding machine is employed, the machine being equipped with a 20K alundum wheel. The truing device, which is shown in place on the machine in Fig. 3, is provided with a templet *A* which is formed to the desired shape. The diamond *B* is traversed across the face of the grinding wheel by means of the handwheel *C*, and the roll *D* which controls the movement of the diamond, is held in contact with the templet *A* by means of a spring located under the arm *E*. The pulleys are subjected to rough- and finish-grinding operations and are handled in lots of four, as experience has shown that four pulleys is all that a wheel will grind before it requires re-truing. The rough-grinding is the most important operation as the results obtained at this time are responsible for the accuracy of the finished pulleys.

In truing the grinding wheel for the roughing operation, the diamond is traversed very rapidly across the face of the wheel and leaves it quite rough. This condition is desirable as the pulleys are out of round as much as 1/32 inch in some cases, and as a result it is necessary for the grinding wheel to cut both freely and rapidly. The wheel is fed straight into the work, grinding one crown and one beveled face at each traverse. After four pulleys have been rough-ground in this way, the grinding wheel is dressed preparatory to the performance of the finishing operation. In truing the wheels ready for the finishing cut, the diamond is traversed across the face of the wheel at a much slower speed and leaves the face of the wheel very smooth. After truing the grinding wheel, the four pulleys are finish-ground by feeding in the wheel as in the case of the roughing operation, and merely cleaning out the marks left by the roughing cut. The grinding machine table is located for each step of the pulley by means of a spacing bar which brings it up to a positive stop for each successive step on the pulley. The rate of production is eight pulleys an hour, which includes the performance of both roughing and finishing operations. This means that from 75 to 80 pulleys are ground per day.

When one stops to consider the very satisfactory results which are obtained by this method, and the condition of the pulleys as they come to the grinding machine, it will be granted that the rate at which the work is turned out is exceptionally high. In order to give an idea of the degree of accuracy which is obtained, it may be mentioned that the wheels will not pass inspection if a step runs 0.005 inch out of true, and on most wheels the error does not exceed 0.003 inch. The finish is perfect. To those who have had experience in using a lathe to machine frail pulleys of the kind referred to in this article, trying to keep them as nearly round as possible and still maintain a satisfactory rate of production, these results will be as much of a surprise as they were to the writer, the first time he saw the work done. The method described will, therefore, no doubt be of interest to mechanics in general, and is of considerable value.

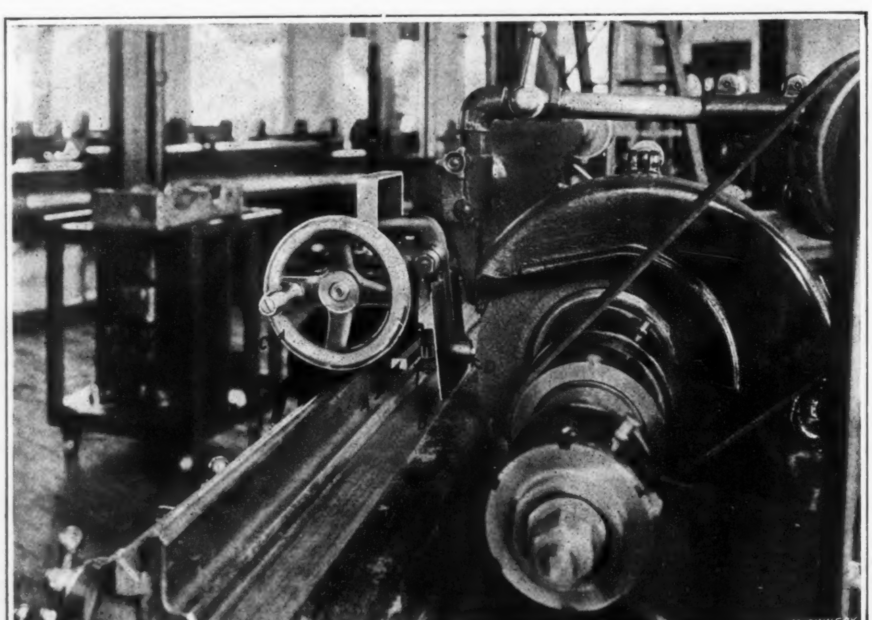


Fig. 3. The Wheel Truing Device set up on Grinding Machine ready for use

* For other articles on the grinding of pulleys published in MACHINERY, see "Grinding Crowned Pulleys" by Howard W. Dunbar, July, 1915, and other articles there referred to.

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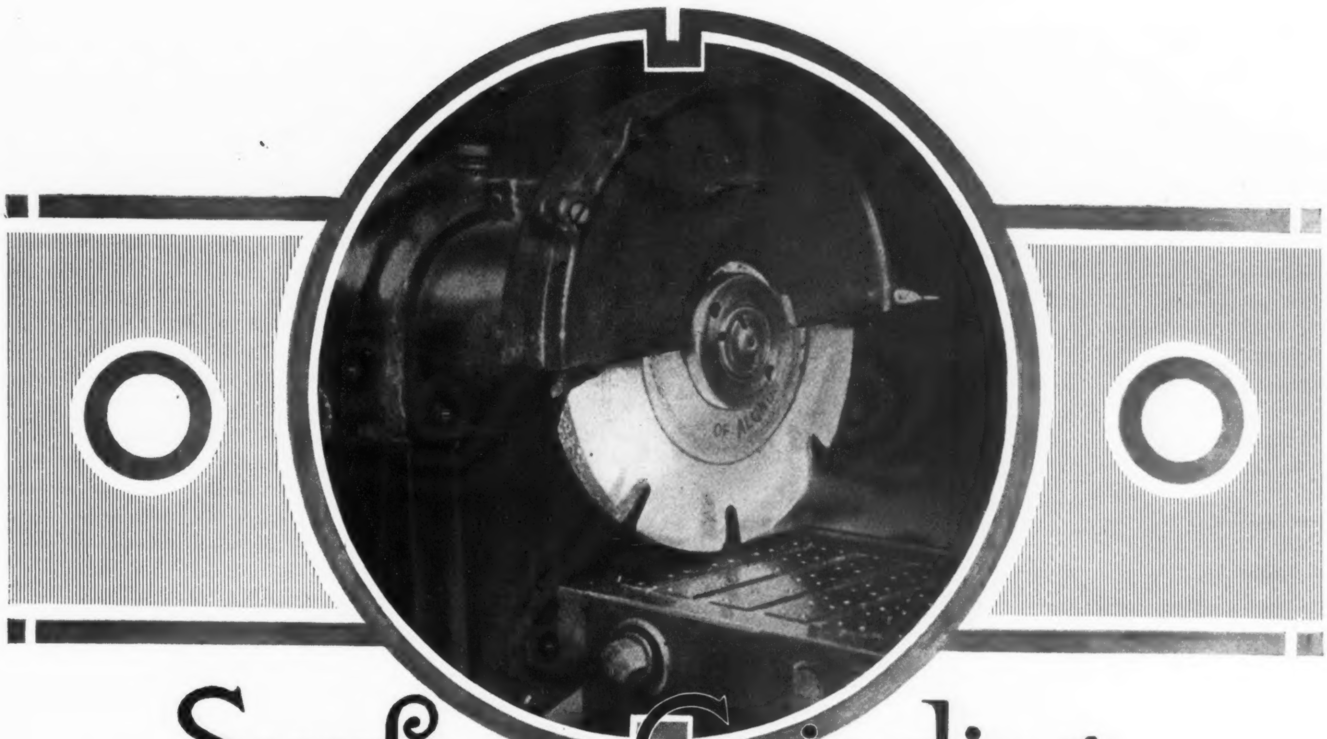

# Surface Grinding

## Methods of Grinding Plane Surfaces on Reciprocating and Rotary Surface Grinding Machines*

by Douglas T. Hamilton†

THE grinding of plane surfaces is called surface grinding and differs from cylindrical grinding in many respects. In the first place, the wheel makes greater contact with the work, especially when cup or cylinder wheels are used; consequently, more trouble is experienced with heating and warping. Surface grinding in connection with tool-room work is generally done dry, and is used chiefly as a means for correcting hardened parts or in cases where exceptional accuracy is desired. It is also used for sharpening tools such as punches and dies, etc. When surface grinding is done wet, little trouble is experienced in heating and warping, but it is not always feasible to use water or other cooling lubricants, owing to the nature of the work, and other requirements, and dry grinding must sometimes be resorted to. In the following will be given several interesting methods for preventing undue heat and warping in grinding dry, as well as examples of work with complete data.

### Methods of Presenting Wheel to Work for Surface Grinding

Surface grinding is done on several different types of machines, some of which are adapted principally to tool-room work and others to general manufacturing. The most common method of grinding a flat surface and one that is generally used on tool-room work is shown at *A* in Fig 1. The work *a* is traversed back and forth beneath the grinding wheel *b*, as indicated by the dotted line, and either the wheel or work is fed laterally at each end of the stroke, so that the wheel gradually grinds the entire surface.

With this method of grinding, especially on thin work, considerable trouble is experienced with local heating and warping. In order to reduce this trouble to a minimum, light cuts with coarse traverse feeds—almost equal to the width of the face of the wheel per each stroke—are advisable. The chief cause of warping is due to the fact that the heat generated by grinding cannot be absorbed quickly enough by the body of the metal to allow it to expand uniformly and the expansion of the heated surfaces causes it to assume a convex shape. When the wheel is removed and the heat has been absorbed by the work, the surface which has been ground will be concave, and to grind it perfectly flat, light cuts with fast side feeds of the wheel are necessary in order to insure a more even distribution of heat.

Another method of producing flat surfaces is shown at *B* in Fig. 1. In this case, it will be noticed that the wheel *b* is slightly greater in width than the work, and covers the entire surface to be ground. When using this type of wheel, the grinding must be done wet as the surface contact of the wheel on the work is greatly increased. When the grinding is done wet, very accurate work can be secured.

The diagram at *C* shows still another method of producing flat surfaces. The wheel *b* in this case is of the cylinder or ring type, and the vertical surface *c* is ground by being traversed past the face of the wheel; hence this is often called face grinding. This method is used quite extensively in the grinding of comparatively large castings such as crank-case covers, gear housings, crank-cases, and similar work.

The diagram shown at *D* illustrates the operation of what is known as the vertical surface grinder. The grinding is done by either a cup or cylinder wheel *b* which revolves

* For additional information on grinding, grinding wheels, and allied subjects see "Internal Grinding," in the August, 1915, number and other articles there referred to.

† Associate Editor of MACHINERY.

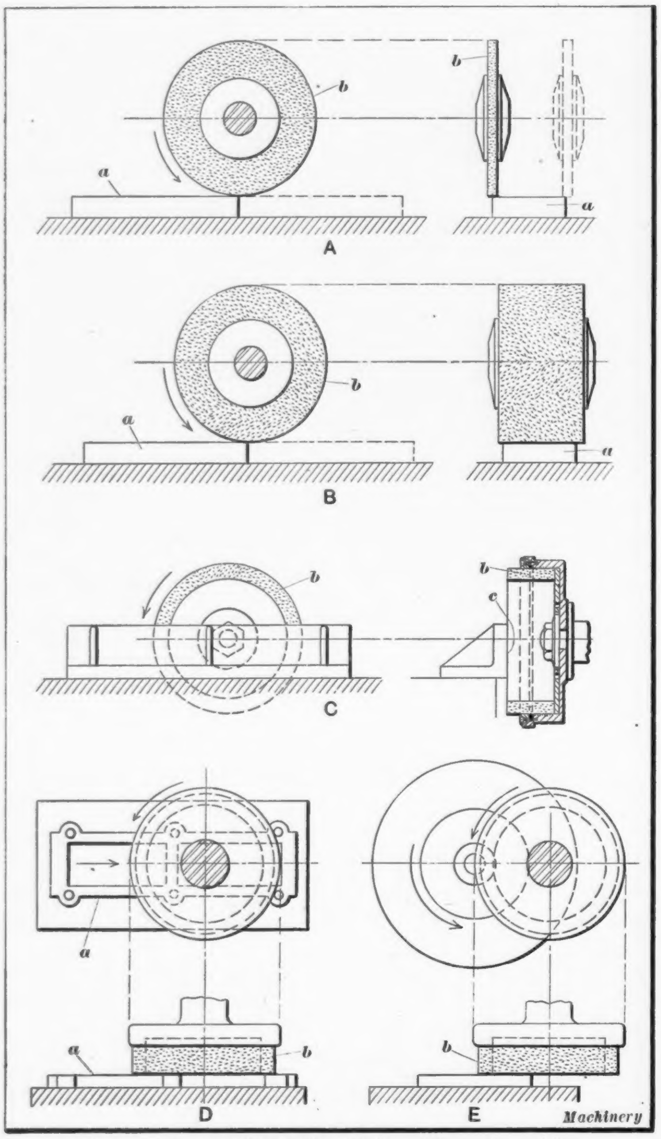


Fig. 1. Diagram illustrating Various Ways of applying Grinding Wheel to Work

about a vertical axis. The work *a* is held on a reciprocating table by means of a magnetic chuck or other device, and is traversed back and forth beneath the grinding wheel. The wheel-head remains stationary as far as lateral motion is concerned, and is fed down gradually at the end of each stroke until the desired amount of material has been removed. The grinding is done wet.

The diagram shown at *E* illustrates the operation of another type of vertical surface grinding machine. In this case the work-table has a rotary instead of a reciprocating movement, and the head carrying the cylinder wheel *b* is fed down a certain amount for each revolution of the work-table. This type of machine is suitable for grinding a large variety of work, such as piston rings, facing sides of ball bearing race rings, and many other machine and engine parts. It can also be used for the grinding of the sides of saws, the required clearance being obtained by setting the axis of the wheel-spindle to an angle less than 90 degrees with the top surface of the work-table.

### Cooling Water for Surface Grinding

When it is possible to use water, the trouble generally experienced from heating and warping of the work can be overcome. For the grinding of cast iron and hardened steel, sufficient sal-soda should be added to the water to prevent rusting. For grinding soft steel, it is advisable to add some cutting oil to the soda water, as this will improve the finish on the work. The amount of oil used in the soda water is generally in the proportion of 1 gallon of mineral lard oil to 32 or 35 gallons of soda water. On machines of the type illustrated by the diagrams *D* and *E*, Fig. 1, plenty of cutting lubricant should be used inside the rim of the wheel, as over-heating of the wheel-face is likely to cause cracking. In most cases, no additional lubricant would be required except for broad surfaces where it may be necessary to use an outside nozzle to assist in cooling the work.

### Preventing Thin Work from Warping When Grinding Dry

When it is necessary to grind thin pieces accurately, many different methods to prevent warping are resorted to. One method that has been used with success is illustrated diagramatically in Fig. 2. The piece to be ground is ⅛ inch thick, ¾ inch wide, by 6 inches long, and is made from steel casehardened. In grinding this piece by holding it in direct contact with the face of the magnetic chuck, it is practically impossible to bring it to a uniform thickness. The method adopted in grinding this particular piece was to rough it out by holding it in direct contact with the magnetic chuck, leaving about 0.002 inch to remove in finishing. Two

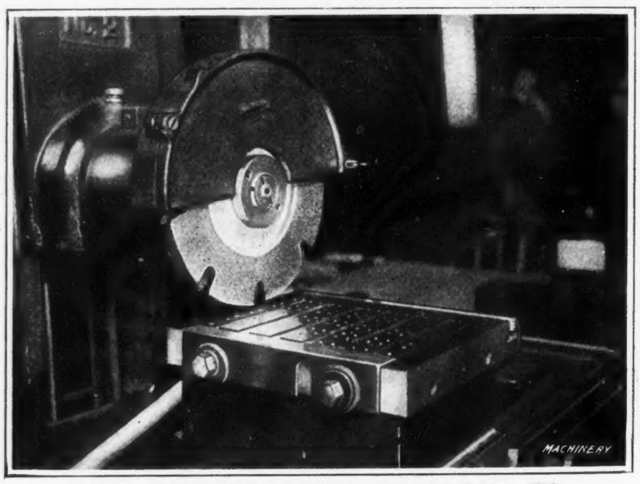


Fig. 3. Method used in holding a Number of Very Thin Pieces on a Heald Magnetic Chuck

accurately ground parallel strips were then placed on the magnetic chuck with the work located on them in about the position shown. The current was then turned on for the operation of finish-grinding. The first step was to true the face of the wheel, which it will be noticed, is provided with eight diagonal notches cut in its periphery at an angle of 45 degrees with the axis of the wheel-spindle. The work was then ground by taking very light cuts with coarse side feeds and rapid table traverses, the work being inverted after taking a cut from each side.

By holding the work in this manner, warping was practically eliminated because of the reduced chances for overheating. A current of air is allowed to pass through freely under the work at all points, except where it contacts with the parallel strips. In addition, the diagonal notches in the wheel-face convert the wheel into a fan, assisting in cooling the work. Even with this method of holding and grinding, it would be impossible to get the piece absolutely flat without inverting it after every cut. This method, of course, is not recommended for manufacturing purposes as the expense would be prohibitive and this illustration is given simply to show how a thin piece of work can be ground accurately when it is impossible to use water.

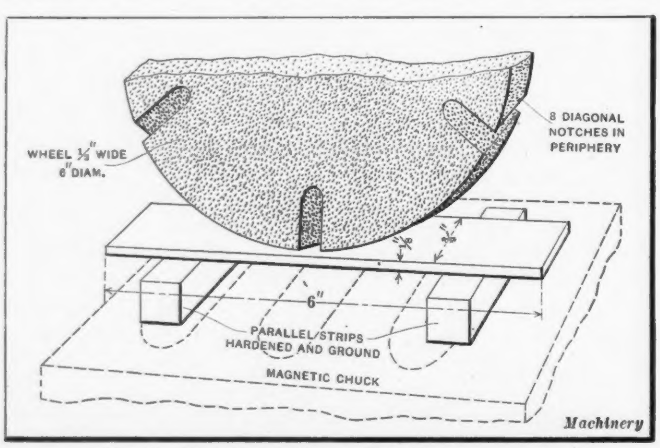


Fig. 2. Method of holding a Thin Piece to prevent warping when grinding Dry

Figs. 3 and 4 show another method of holding thin work to prevent warping when grinding. In this case the work being ground is a steel plate 0.050 inch thick by 3/8 inch wide by 1 1/16 inch long, which must be ground to a limit of 0.0005 inch in thickness from end to end and parallel. The method of grinding these pieces was to arrange 48 of them on a Heald 6 by 8 inch rectangular magnetic chuck in the manner shown in Fig. 4. Instead of placing the chuck on the grinding machine table in the usual manner, that is with the magnetic poles parallel with the axis of the wheel-spindle, the position was reversed so that the poles were at right angles to the axis of the wheel-spindle. The pieces were then arranged in double rows, butted together, and overlapping the non-magnetic surfaces in the manner illustrated. While this arrangement reduced to a certain extent the strength of the magnetic flux, it made possible the holding down of the pieces with an equal pressure for their entire length. In order to prevent undue heating, a wheel of the shape shown in Fig. 3 was adopted. The efficiency of this method of holding is proved by the fact that 1320 pieces were ground to the limits required in 30.6 hours.

### Holding Warped or Sprung Work

If a thin or light piece is warped when it comes to the surface grinding machine, considerable care must be exercised in holding it in order to prevent distortion. For instance, if it is held on a magnetic chuck, the pull of the chuck may so distort it as to make it out of true when released. Turning such a piece over several times during the grinding will, to a certain extent, eliminate much of the variation. When grinding large thin parts with a vertical-spindle rotary type of machine, warping can be minimized by placing the work central on the chuck, using suitable stops, and grinding the first side without using any magnetic current.

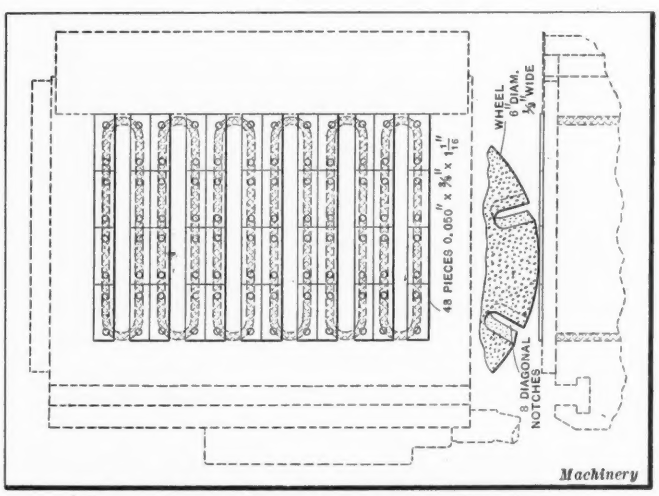


Fig. 4. Diagram showing Arrangement of Pieces held on Chuck shown in Fig. 3

This operation need only be carried far enough to clean up the surface on one side to a fair bearing and present a flat surface to the chuck so that it can be held magnetically. Large thin plates such as circular saws are often best ground without using the magnetism at all. A good general rule to follow in practically all work that is warped or sprung out of shape, is not to hold it magnetically for grinding the first side, but to support it in some other way.

### Holding Non-magnetic Work

When grinding brass, aluminum and other non-magnetic materials, the work must be clamped or secured in some other way than by direct magnetism. The method generally used is to employ a vise, clamping fingers, or other work-holding fixture for retaining the part to be ground where the use of such a device is possible. If the work is quite heavy, it can be held on a chuck by simply using a backing-up strip to prevent it from shifting. When the piece is in the shape of a ring or plate, and a vertical spindle rotary type of machine is used, it can be ground by being placed centrally on the table, as it will be held down by the wheel itself and need only be centered by stops, or by a plug in the center of the hole, if there is one in the piece.

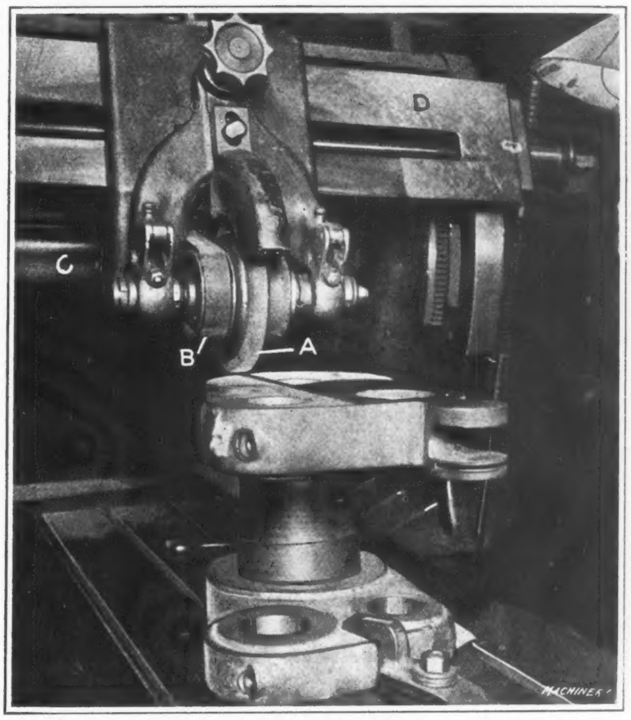


Fig. 5. Grinding a Milling Machine Wrist on a No. 4 Brown & Sharpe Surface Grinding Machine

The magnetic chuck can sometimes be used to advantage for holding non-magnetic work by using strips or stops as shown in Fig. 7. In diagram *A*, four small steel blocks are placed and held on the magnetic chuck as illustrated, and prevent the casting *b* from shifting, enabling it to be ground. Still another method is shown at *B*, where a chuck ring *c* and four pieces *d* are used for supporting the work and preventing it from shifting on the magnetic chuck. Still another method is shown at *C* where the pieces for supporting the work are clamped by bolts to the chuck. This method can also be used with a non-magnetic chuck.

Non-magnetic work of box form can be held magnetically by using blocks of cast iron or steel which are placed inside the parts to be ground. The magnetic attraction of these blocks to the chuck will be strong enough to hold the work, provided the thickness of the latter does not exceed 1/16 inch. The same method has been very successful for holding thin pressed steel boxes, the sides of which were so high that the boxes could not be held rigidly enough for grinding the upper edges, without placing the magnetic blocks inside.

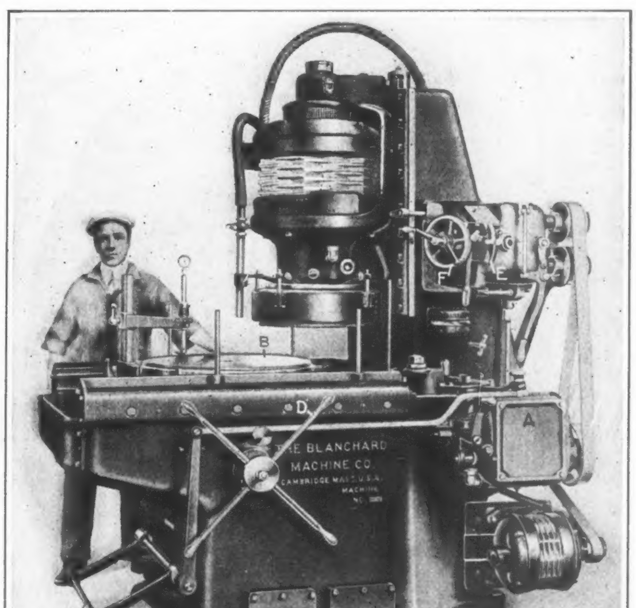


Fig. 6. Blanchard High-power Vertical Surface Grinder—Motor-driven Type

### Grinding Large Castings on Planer Types of Surface Grinding Machines

For grinding large machine parts such as milling machine tables, wrists, etc., the Brown & Sharpe No. 4 surface grinding machine, as shown in Fig. 5, is sometimes used. This particular machine carries a disk wheel *A* which is driven from the overhead works by means of the pulley *B* from a drum pulley *C*. The grinding wheel-head is held on the rail *D* and can be moved back and forth by means of power or hand feed, power feed being effected in practically the same manner as on a planer. It will be noticed that the rail swings on an arc; the reason for this is that because of the method of driving, the belt would be tightened and loosened if the rail were adjusted up and down in a vertical position. The point from which the rail swings is the axis of the drum pulley *C*. When grinding parts on a surface grinding machine of the planer type, the work is generally clamped direct to the table by means of bolts, as illustrated, or is held up against angle plates, the method depending entirely on the character and shape of the work.

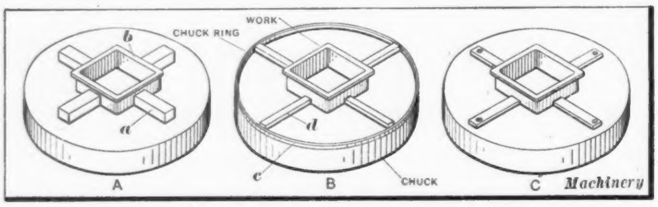


Fig. 7. Methods of holding Non-magnetic Work on Vertical Surface Grinder

### Wheel Speeds for Surface Grinding

The grinding wheel speeds for surface grinding are generally less than those for external cylindrical grinding, and vary between 3000 and 5000 feet per minute. The speeds are generally higher for a disk wheel than for a cylinder or ring wheel, the latter grinding on the edge instead of on the circumference. On surface grinding machines of the type shown in Fig. 3, which carry disk wheels, the wheel speed is kept as close as possible to 5000 feet, whereas on the Blanchard machine, the wheel speed is about 4000 feet per minute. On the Heald rotary surface grinder where a disk wheel is used, the speed is about 5000 feet per minute.

### Work Speeds and Feeds for Surface Grinding

The feeds and speeds to use for surface grinding depend largely upon the method of applying the wheel to the work. On the type of surface grinding machine that operates on the principle shown at *A* in Fig 1, the traverse speed of the table varies from 25 to 50 linear feet per minute, depending upon material, the width of face of the wheel used, and the depth of cut taken. Usually the cross-feed is equal to ½ or ¾ the width of the grinding wheel face, but this lateral feed is varied, according to the finish required. When the piece is to be finished in one cut and a fairly smooth surface is required, a wheel ¾ inch wide, and a feed of from 1/16 inch to ⅛ inch per traverse is generally used. The depth of cut varies from 0.0005 to 0.003 inch.

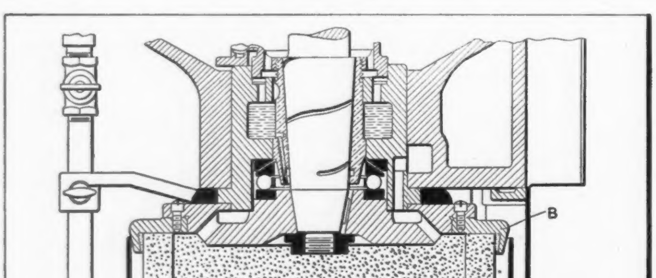


Fig. 8. Section showing how Cylinder Wheel of Blanchard Vertical Surface Grinder is held and mounted

When grinding on machines working on the principle shown at *B* in Fig. 1, if the work is less than 10 inches in width, the wheel is not fed across the work, but the work is traversed back and forth under the wheel, the complete surface being finished in one cut. On this machine, the table traverse varies from 25 to 50 linear feet per minute, and the depth of cut from 0.0005 to 0.003 inch per traverse.

On surface grinding machines that work on the principle shown at *C*, Fig 1, the table is traversed at the rate of from 25 to 50 linear feet per minute, and the cut varies in depth from 0.001 to 0.005 inch per traverse. When this type of machine is used for large castings, a heavier cut is taken than where the work is smaller or more accurate.

Where the grinding is done on a machine of the type illustrated at *D* in Fig. 1, the table is traversed back and forth and usually the ring or cylinder wheel used covers the entire width of the surface being ground. When this is the case, the only two points to consider are the table traverse and the down feed of the wheel per traverse. The table traverse varies from 15 to 50 linear feet per minute, and the down feed from 0.0005 to 0.002 inch per traverse.

On surface grinding machines working on the principle shown at *E*, Fig. 1, where the work and wheel both rotate but are not traversed, the two conditions to consider other than the wheel speed, are the speed of the work-table and down feed of the wheel per revolution of the work-table. Generally the down feed of the wheel-head varies from 0.001 to 0.002 inch per revolution of the work-table and the table speeds vary greatly depending upon the type of machine and the character of the work. The type of grinding wheel

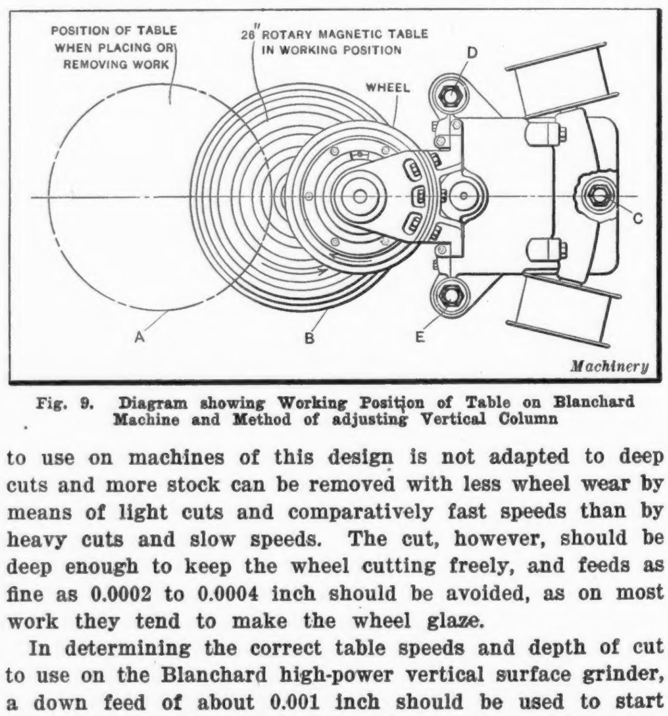


Fig. 9. Diagram showing Working Position of Table on Blanchard Machine and Method of adjusting Vertical Column

to use on machines of this design is not adapted to deep cuts and more stock can be removed with less wheel wear by means of light cuts and comparatively fast speeds than by heavy cuts and slow speeds. The cut, however, should be deep enough to keep the wheel cutting freely, and feeds as fine as 0.0002 to 0.0004 inch should be avoided, as on most work they tend to make the wheel glaze.

In determining the correct table speeds and depth of cut to use on the Blanchard high-power vertical surface grinder, a down feed of about 0.001 inch should be used to start with. If the wheel glazes, rough the face with a carborundum block held in the hand, and try the wheel again, using the next lower table speed with slightly increased down feed. If the wheel appears to be too soft and wears away too rapidly, increase the table speed and decrease the down feed. Obviously a down feed of 0.002 inch with a table speed of 6½ revolutions per minute removes the same amount of stock per minute as a down feed of 0.001 inch with a table speed of 13 R. P. M. Varying the speed and feed to improve the cutting action of the wheel need not, therefore, change the rate of cutting. It should be clearly understood, however, that in order to obtain satisfactory results, the wheel must be suited to the work. The variations of speeds and feeds will not adapt an unsuitable wheel to the work and they are simply used as an aid to secure the highest possible economy of operation with a wheel that has been found suitable for the work in hand.

### The Blanchard High-power Vertical Surface Grinder

A surface grinding machine that works on the principle shown by the diagram at *E* in Fig. 1, is shown in Fig. 6. This is the latest type of Blanchard high-power vertical sur-

face grinder, and is motor-driven. The base is made of one casting and is of box form heavily ribbed inside, forming a rigid support for the various parts of the machine. The column is of box form with internal stiffening webs, and carries the wheel-head. The slide upon which the wheel-head fits is 36 inches long and has three accurately fitted tapered gibs extending the entire length to provide against wear. The slides on the wheel-head are 30 inches long, accurately scraped to master plates and carrying a separate housing which contains the bearings for the upper end of the spindle. The spindle is made from a forging of 0.40 to 0.50 per cent carbon steel, and is finished all over by grinding; it is fitted with ball-thrust bearings and an automatic spring take-up; the side pull is taken by a bronze bushing at the lower end of the spindle and by a radial ball bearing at the upper end.

The motor used on the wheel-head is 20 horsepower and of the alternating-current type. The field frame is centered in a bored recess in the wheel-head and is bolted to it only at the lower end. The upper end of the field frame has a cover which keeps out dirt and fills the space between the field and the upper spindle bearing. The cover carries an oil catcher which traps any oil escaping from the upper bearing, and conducts it away from the motor. A screened opening extending around the cover admits air into the interior of the motor to which it is circulated by fans on the spindle and discharged through holes in the lower part of the motor frame. These fans force a large quantity of air to the motor, cooling it effectively even when severely overloaded.

The gear-box shown at *A*, Fig. 6, through which table *B* is rotated, provides for eight changes of speeds varying in revolutions per minute as follows: 5, 6.5, 8.5, 13, 17.5, 22, 29 and 44. The chuck is usually started and stopped by means of a hand lever on the gear-box. The foot treadle *C* is used for moving the chuck through part of a revolution when placing the work in position for grinding. The table is brought into position under the wheel, after the work has been located in the chuck, by operating turnstile *D*. The correct working position for table is shown in Fig. 9.

The vertical feed for the wheel-head can be effected either by hand or power, and is varied by adjusting the feed variator *E* (Fig. 6). Feed wheel *F* is graduated in such a manner that a movement of ½ inch on the circumference of the wheel means a down feed of 0.001 inch. Down feeds of the wheel-head can be varied from 0.0002 inch to 0.005 inch per revolution of the work-table by steps of 0.0002 inch. The down feed is also provided with an automatic stop which can be set to disconnect the feeding movment when the desired thickness on the work is obtained. The water tank has a capacity of 64 gallons, and is supplied with a submerged centrifugal pump having an 8-inch fan and a 1½-inch discharge pipe.

### Mounting and Truing Wheels

The grinding wheels used on the Blanchard, motor-driven, vertical surface grinders are 18 inches in diameter, 5 inches

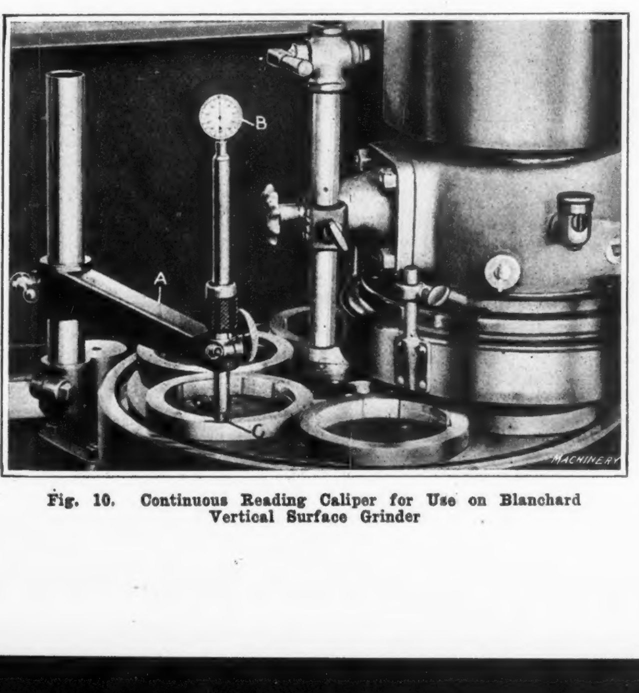


**Fig. 10. Continuous Reading Caliper for Use on Blanchard Vertical Surface Grinder**

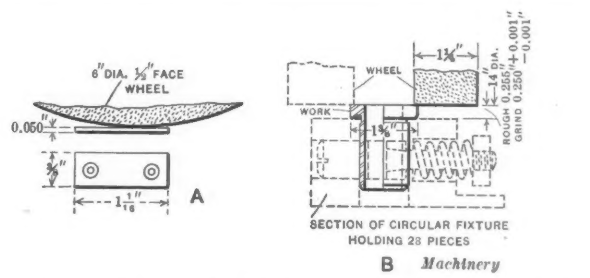


**Fig. 11. Examples of Thin Work ground without Distortion and Data on grinding Flange of a Bushing**

A

**Work:**—Pivot plate made from 0.20 per cent carbon, cold-rolled strip steel, casehardened 0.012 inch deep.

**Operation:**—Grinding both sides with Norton (vitrified) alundum wheel; grain 38-46, grade G; 6 inches in diameter, ½-inch face; wheel speed, 3183 R. P. M.—5000 feet surface speed; provided with eight diagonal notches around its periphery; amount removed from each side, 0.0015 to 0.002 inch.

**Remarks:**—Table is traversed back and forth by hand and also in and out by hand; 48 pieces held at one time on a Heald 6- by 8-inch flat magnetic chuck; pieces arranged along or parallel with magnetic poles instead of spanning them; four traverses to complete each side; 250 pieces turned out per each truing of wheel; production, 1320 in 30.6 hours; machine used, No. 2 Brown & Sharpe surface grinding machine.

B

**Work:**—Bushing for steering spindle, 0.15 per cent carbon open-hearth steel, carbonized and hardened.

**Operation:**—Surface grinding large end with a Norton (vitrified) alundum wheel; grain 24, grade L; 14 inches in diameter, 1¼-inch face; speed 1400 R. P. M.—5126 feet surface speed; table speed, 100 R. P. M.; head travel or traverse speed, 42.5 linear inches per minute, amount removed, 0.007 to 0.010 inch.

**Remarks:**—Wheel is traversed back and forth across work, which is held in a special ring fixture carrying 28 bushings; production, 4000 in nine hours; machine used, Heald rotary surface grinding machine.

deep and with rims varying from 1- to 1½-inch thick, depending upon the work to be ground; whereas those used on the belt-driven are 16 inches. Of the 5 inches total depth, 3 15/16 inches can be used. As shown in Fig. 8, the grinding wheel *A* is cemented into a cast-iron retaining ring *B*, which, in turn, is held to a flange retained on the lower end of the vertical spindle.

There are several methods of mounting wheels of this type. One is to mix equal parts of Portland cement and sand with water, to the consistency of a thin paste; then wet the wheel thoroughly all over and spread a thin layer of the cement paste on the end that is to go next to the retaining chuck. The next step is to remove all dirt and grease from the inner surfaces of the retaining ring, and place the wheel centrally in the ring with the cemented end down; next fill the space between the wheel and the iron ring with the cement paste, using a thin piece of metal to ram it in. All surplus cement should be removed from the outside of the ring, and then the wheel should be covered with clothes and placed in a covered box or barrel. The wetting of the wheel before cementing and keeping it damp while the cement sets, are very important. Wheels should be allowed to set two days, or more, varying with the brand of cement used. If the inside of the ring wheel has not already been "waxed" it should be covered with parafine wax painted on hot to prevent any trouble from the water spraying.

Another method of cementing in cylinder or ring wheels, which is much quicker than that previously described, is to use melted sulphur. The wheel and ring are cleaned as before, then the sulphur is melted and poured into the intervening space between the wheel and ring. The sulphur hardens as it cools, and the wheel may be used within a short time after the sulphur has been poured in.

For truing the wheel used on the Blanchard vertical surface grinder, a stick of special carborundum mounted in a cast-iron holder is used. This is applied to the wheel by holding the carborundum stick-holder on the magnetic table and sliding the table in and out to pass the carborundum stick across the face of the wheel. Care should be taken, of course, to see that the truing device is held magnetically before being passed under the wheel. A new wheel should be trued before using, but after this first truing has been done the wheel should not be touched until it glazes. As soon as glazing occurs, the wheel-face should be roughed

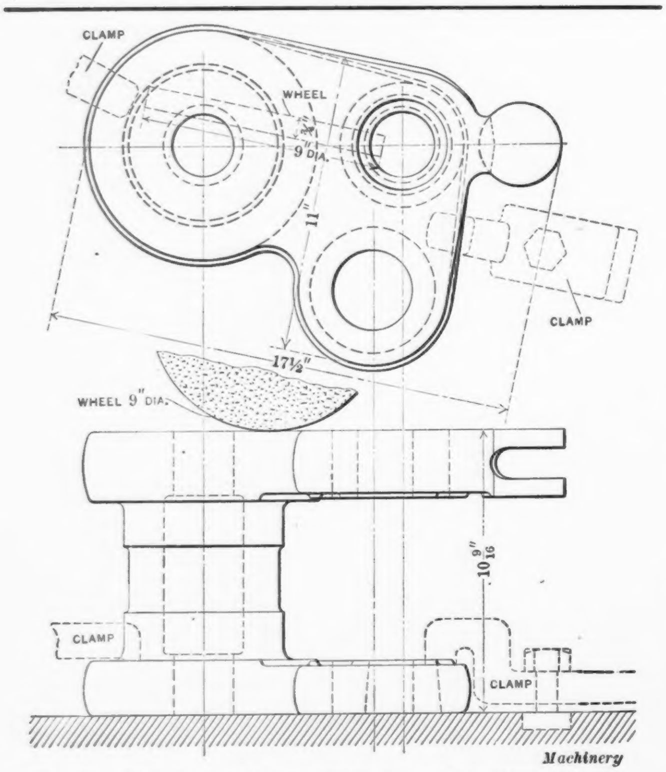


Fig. 12. Method of grinding a Wrist for a Plain Milling Machine

**Work:**—Wrist for a plain milling machine made from iron casting.
**Operation:**—Surface grinding one face for finish with a Carborundum Co.'s (vitrified) carborundum wheel, grain 36, grade P or M; 9 inches diameter, ¾ inch face; speed, 2122 R. P. M.—5000 feet surface speed; work speed—or table travel—35 linear feet per minute; traverse feed, 1/16 inch per traverse of wheel; amount removed from surface, 0.005 to 0.007 inch.
**Remarks:**—Narrow face wheel is fed once across work; work is held down on table of grinding machine by clamps (see illustration); 8 pieces turned out to each truing of wheel; production, 9 to 10 per hour; machine used, No. 4 Brown & Sharpe surface grinding machine.

up with a piece of carborundum held in the hand. A wheel that requires this treatment frequently is too hard or too fine for the work and should be changed. The right wheel for the job will run until worn out without dressing. It should also be remembered that in a vertical surface grinder of this type, the wheel-face does not need to be kept flat in order to secure flat work.

### Working Relation of Table to Wheel on Vertical Surface Grinder—Setting Wheel-head to Grind Work Concave

For loading the magnetic table or chuck on a Blanchard vertical surface grinder, the table is moved out as previously described, bringing it out of contact with the grinding wheel, as shown by the dotted line *A* in Fig. 9. The work is then placed on the magnetic chuck, after which the table is moved in until the outer rim of the wheel coincides with the central axis of the work-table, as shown at *B*. The table and work are then rotated.

A word here about keeping the chuck clean may be of interest. It is the practice of the Blanchard Machine Co. to use a loose ring of sheet steel laid around the group of pieces to be ground (as will be seen in the illustrations further on) and sometimes another ring is laid inside the piece. This is very clearly shown in Fig. 19, which illustrates a number of rifle hammers in place for grinding. When one side of the pieces has been ground, the chuck is moved to the end of the machine, the magnetism turned off, and both work and the chuck rings removed, leaving the chuck face clear of everything except the water and chips. Cleaning is then done with a rubber edged scraper or squeegee—the same device that is used for cleaning plate glass windows. By depressing the treadle at the front of the machine, the operator can set the chuck in motion without leaving his position at the end of the machine and with the squeegee can clean off the chuck face as it revolves, in a few seconds. This is sufficient for all but the most particular work, for which further cleaning is usually given with a cloth.

For straight plain surface grinding, the spindle should be set absolutely square or at right angles with the chuck-face, so that the wheel touches the work on both sides; when the wheel is properly set, limits of 0.0003 inch total variation, can easily be worked to. There are some classes of

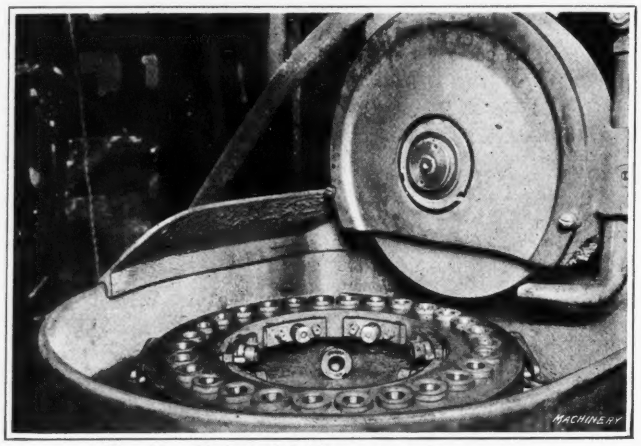


Fig. 14. Method of holding and surface grinding Top Flanges of Bushings

work, however, for which it is necessary to set the wheel-spindle at an angle to the face of the work-table, as when grinding the concave sides of circular saws, etc. To make this adjustment, the rear column support *C*, Fig. 9 is provided with a graduated washer. To set the head for concave work, the three-column support bolts, *C*, *D*, and *E* should be loosened, but the two front washers should not be disturbed. A note should be made of the setting of the rear washer before changing; then turn this washer to the right until the spindle is inclined the desired amount and tighten all the bolts firmly before starting the machine. A slight adjustment of the rear or two side supports may be made by simply loosening the bolt which is to be adjusted.

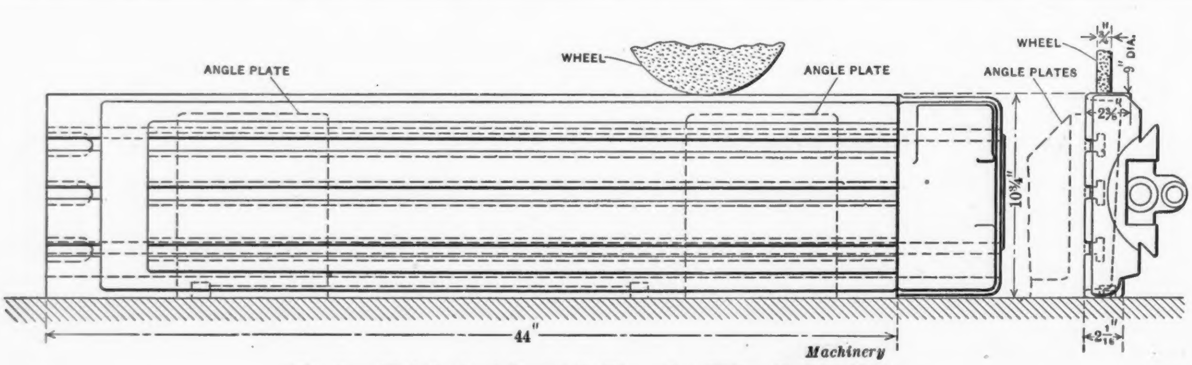


Fig. 13. Method of grinding Both Edges of a Milling Machine Table

**Work:**—Milling machine table made from iron casting.
**Operation:**—Grinding both edges for finish with a Carborundum Co.'s (vitrified) carborundum wheel, grain 36, grade P; 9 inches in diameter, ¾ inch face; speed, 2122 R. P. M.—5000 feet surface speed; table traverse, 35 linear feet per minute; cross feed, 1/16 inch per traverse; amount removed, 0.005 to 0.007 inch.

**Remarks:**—Narrow face wheel is fed once across work; work is held down on table by clamps and up against two angle plates (see illustration); 2 pieces turned out per each truing of wheel; production, 5 per hour, both edges ground; machine used, No. 4 Brown & Sharpe surface grinding machine.

### Measuring Work on Surface Grinding Machines

The method of measuring work on surface grinding machines depends entirely on the type of machine. On machines of the type where the wheel-head is lowered or elevated by means of an adjusting screw, the graduated index on the wheel is generally used as a guide for grinding the work down to approximately the required thickness. The work is then removed from the chuck and measured from time to time until the desired thickness has been obtained. After several pieces have been ground it is possible to grind very close by means of the index wheel, as the only variation is due to the wear of the wheel.

On the Blanchard vertical surface grinder a device known as a "continuous reading caliper" is applied directly to the work and readings are taken continuously as the work-table rotates. This attachment consists of an arm *A*, as shown in Fig. 10, which is clamped to a vertical post and carries in its front end a spindle and other members that operate the needle of a dial *B;* this dial indicates the exact amount, in thousandths of an inch, by which the work thickness

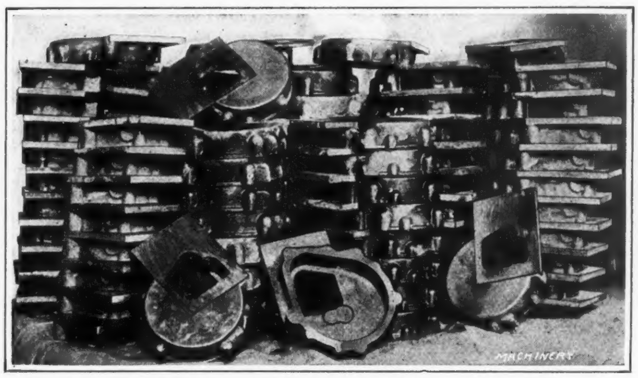


**Fig. 15. Gear Housings ground on Both Sides on a Blanchard Vertical Surface Grinder at the Rate of 60 Pieces per Hour**

varies from the finished size. The reading is secured through a hardened steel button *C* that rests on the work and is connected to the gage. To set the caliper the button is brought down on a sizing block or finished piece, placed on the table, and the dial of the gage-head revolved to bring the zero line into agreement with the needle.

### Examples of Surface Grinding

In the following will be given examples of work that have been accomplished on the various types of surface grinding machines shown by the diagrams in Fig. 1. Surface grinding has always been considered a difficult proposition because of the over-heating and warping of the work; therefore, the examples given in the following should be of interest to those doing this class of work.

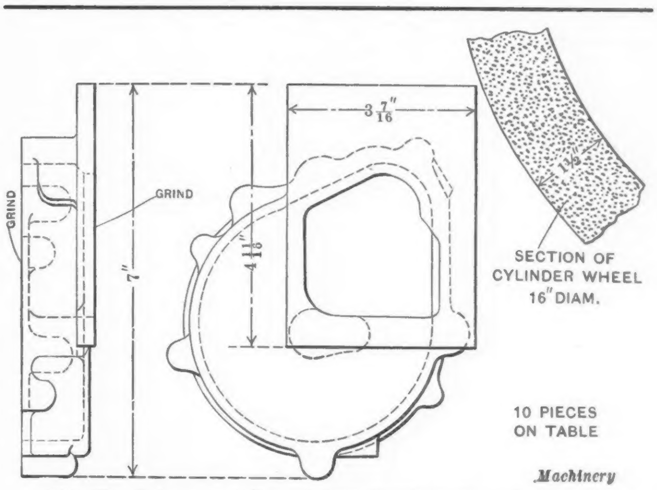


**Fig. 17. Data on grinding of Gear Housings shown in Fig. 15**

**Work:**—Gear housing, cast iron.

**Operation:**—Surface grinding two sides from the rough with an American (vitrified) carbolite wheel; grain 20, grade H; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing and finishing, 13 R. P. M.,—down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side, 0.032 inch.

**Remarks:**—10 of these pieces are held at one time on Blanchard magnetic chuck; grinding time, 7 minutes; handling time, 3 minutes; limits, plus or minus 0.001 inch; production, 60 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

### Grinding Small Thin Plates

Diagram *A*, Fig. 11, shows an example of surface grinding to which reference has previously been made. This is a small pivot plate made from 0.20 per cent carbon, cold-rolled strip steel, case-hardened 0.012 inch deep. It was satisfactorily ground by using a Norton alundum wheel, grain 38-46, grade G, by cutting diagonal notches in the periphery and then using a Heald magnetic chuck to which the pieces were held as previously described.

### Examples of Work done on Planer Type of Surface Grinding Machines

Fig. 12 shows a milling machine wrist which is ground on a surface grinder of the planer type illustrated in Fig. 5. A carborundum wheel, grain 36, grade P or M, 9 inches in

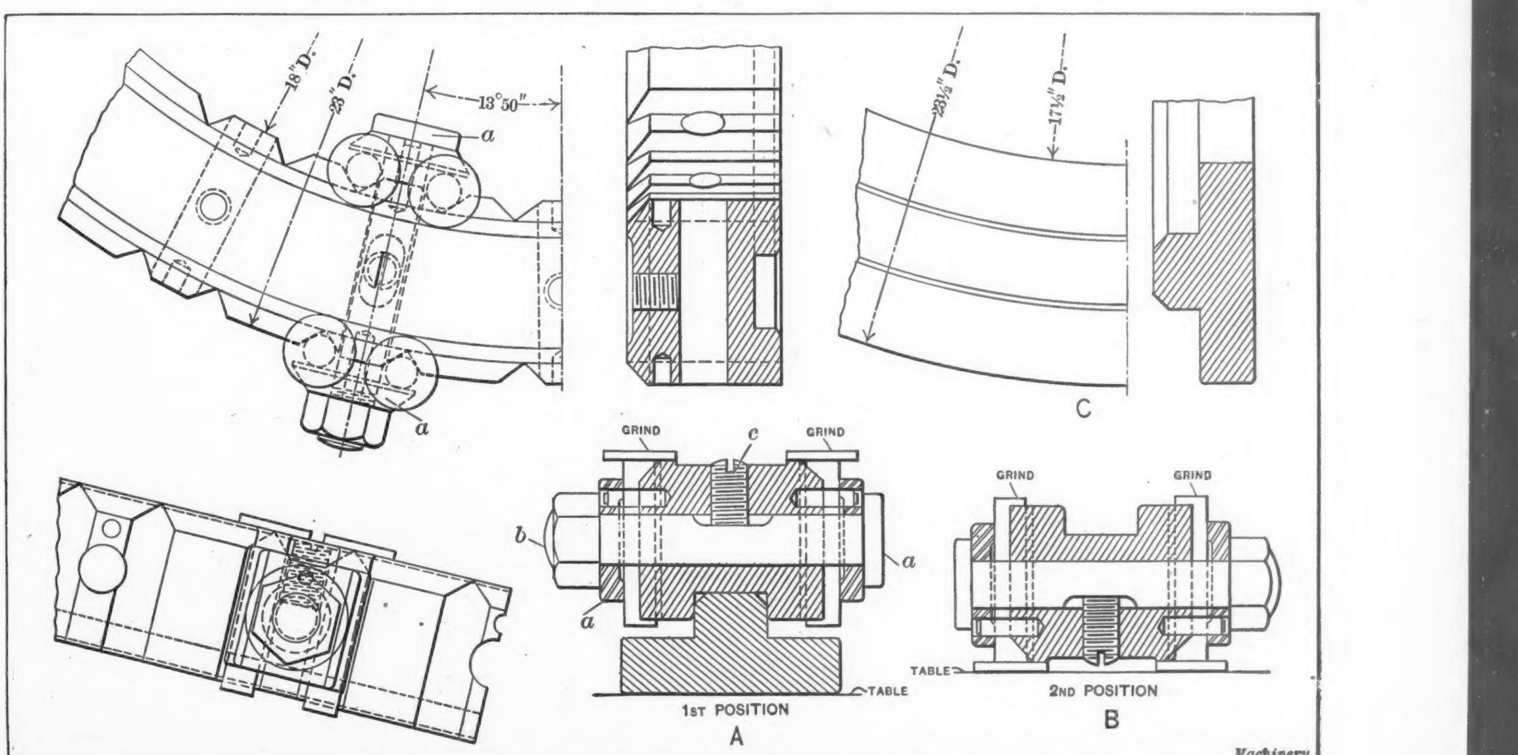


**Fig. 16. Method of holding and grinding Valve Push Rods on a Blanchard Vertical Surface Grinder at the Rate of 720 per Hour**

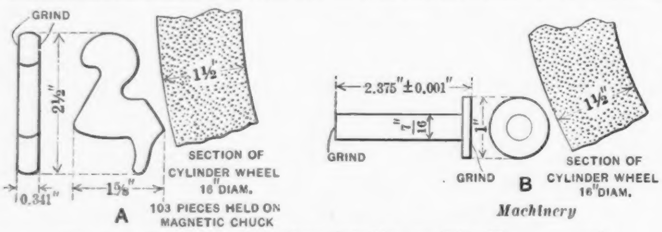


Fig. 18. Examples of Surface Grinding on Rifle Hammers and Valve Push Rods

A

**Work:**—Rifle hammer, soft steel forging, not hardened.

**Operation:**—Grinding both sides from the rough with an American (silicate) corundum wheel; grain 58-24, grade ¾; 16 inches diameter, 1½-inch rim; speed 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 17 R. P. M.—finishing 5 R. P. M.; down feed of wheel, 0.001 inch per revolution of table; amount removed from each side, 0.025 inch.

**Remarks:**—103 of these parts are held at one time on Blanchard magnetic chuck between two retaining rings; grinding time, 8 minutes; handling time, 12 minutes; limits, plus or minus 0.0005 inch; production, 300 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

B

**Work:**—Gas engine valve push-rod, vanadium steel drop-forging, heat-treated.

**Operation:**—Surface grinding both ends from the rough with an American (silicate) corundum wheel; grain 30; grade 1-W; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, 17 R. P. M.; down feed of wheel, 0.0015 inch per revolution of work-table; amount removed from each end, 0.010 inch.

**Remarks:**—104 of these parts are held at one time on a Blanchard magnetic chuck by means of a special clamping fixture; handling time is greatly reduced by providing three fixtures; production, 720 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

diameter, is fed across the work at the rate of 1/16 inch per traverse of the wheel with the work-table operating at a speed of 35 linear feet per minute, and removing from 0.005 to 0.007 inch.

Still another example of a somewhat similar nature is shown in Fig. 13. This is a milling machine table, and the grinding is done on both edges of the table. For this work a carborundum wheel of the same grain and grade as that used in Fig. 12 is used and the other facts concerning the job are also similar. The top of the platen has been accurately finished so that this face is used as a locating point for grinding the edge, the platen being clamped against two accurately finished angle plates. Probably a more satisfactory way of handling this work would be to locate the

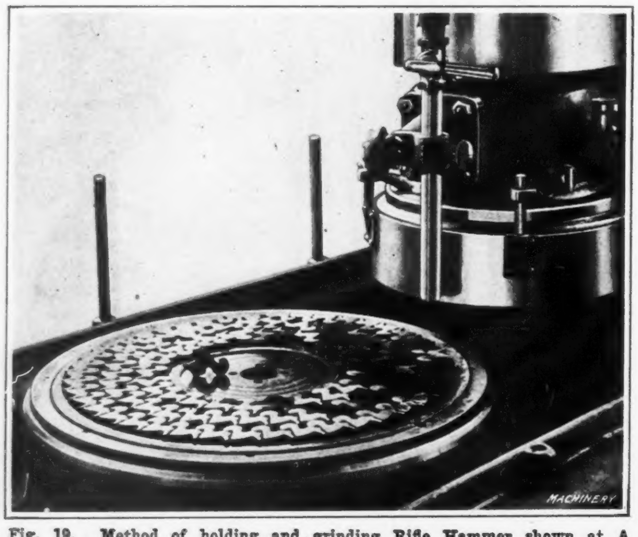


Fig. 19. Method of holding and grinding Rifle Hammer shown at A in Fig. 18, on a Blanchard Vertical Surface Grinder

platen from the V-slide, having several hardened rollers fitting in the lower angle of the slide and resting on hardened blocks, then clamping the work in the position as illustrated, and using the ways simply as a means of getting the sides of the table straight and parallel with the V-ways.

### Grinding Top Face of Flanges of Bushings

An interesting method of handling and grinding the flanges of bushings is shown in Fig. 14. The machine used is a Heald rotary surface grinder carrying a disk wheel 14 inches in diameter, 1¼-inch face. This wheel is traversed back and forth across the top faces of the bushings to grind them to the required thickness. The bushings are held in a special fixture carrying twenty-eight at a time; the fixture, in turn, is clamped to the magnetic chuck. The data for this particular operation are given at *B* in Fig. 11.

The gear housings shown in Fig. 15 represent a good example of surface grinding as handled on the Blanchard vertical surface grinder. These are made from cast iron and 0.032 inch of metal is removed from each side from the rough. Ten of these pieces are held on the magnetic chuck at one time, and the production is at the rate of sixty pieces per hour, as will be seen by referring to Fig. 17 where data regarding the wheel, and the work speeds are given.

### Grinding Valve Push Rods

The valve push rods shown clamped in the fixtures at *A*, see Fig. 16, are examples of work that can be handled on the vertical surface grinder. The grinding is done on both the small and large ends, the push rods being ground to the correct length within limits of plus or minus 0.001 inch. Two operations are necessary. The first operation, which is shown at *A* in Fig 16, consists of grinding the top or largest diameter of the push rod, removing about 0.010 inch. For this operation, a blocking ring of inverted T-section, as shown at *A*, is placed under the fixture. This raises the fixture from the magnetic chuck and prevents the push rods from touching the chuck. For grinding the small ends of the rods, the blocking ring is removed and the fixture is located on the table, as indicated at *B*, the

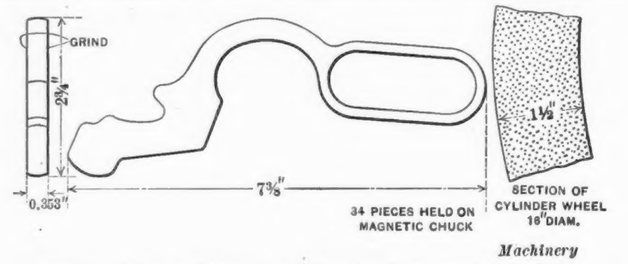


Fig. 20. Data on Levers for Repeating Rifle ground as shown in Fig. 21

**Work:**—Lever for repeating rifle, soft steel forging, not hardened.

**Operation:**—Surface grinding both sides from the rough with an American (silicate) corundum wheel; grain 58-24, grade 1; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 17 R. P. M., finishing 5 R. P. M.; down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side, 0.032 inch.

**Remarks:**—34 of these parts are held at one time on Blanchard magnetic chuck located inside one retaining ring; the pieces are flattened after trimming, and before grinding; grinding time, 6 minutes; handling time, 4 minutes; limits, plus or minus 0.001 inch; production, 204 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

previously ground faces of the rods resting on the magnetic chuck. This feature insures greater accuracy.

The method of clamping the push rods is simple, but effective. The clamping device consists of two blocks *a* through which a shoulder binding stud *b* passes. This stud, in connection with the two clamps, holds four push rods in place. The studs are prevented from turning by

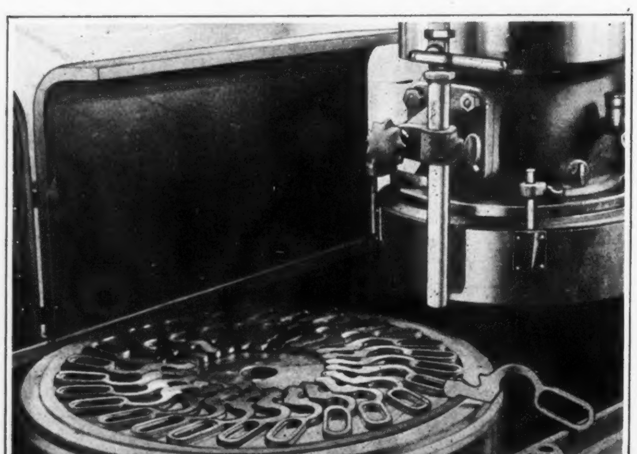


Fig. 21. Method of holding and grinding Lever for Repeating Rifles shown in Fig. 20, on a Blanchard Vertical Surface Grinder

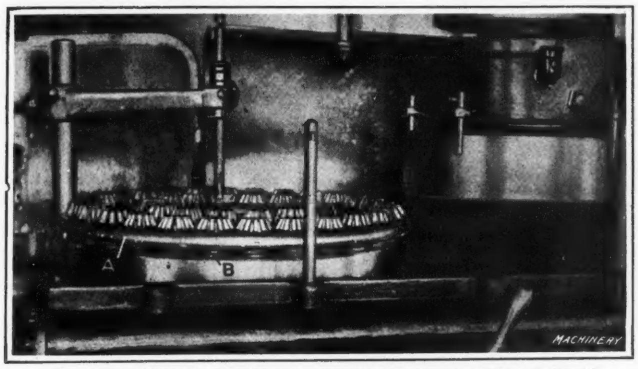


Fig. 22. Method of holding and grinding Front Ends of Bevel Pinions on a Blanchard Vertical Surface Grinder

headless screws *c* resting on flats provided on the studs. The rods are held in V-grooves in the body of the fixture and are located when being placed in the fixture, by the under surface of the head, which rests on the finished top face of the fixture. Three fixtures of this type are provided so that the handling time is reduced to a minimum. Section *B* in Fig. 18 gives all the facts on the grinding of these push rods.

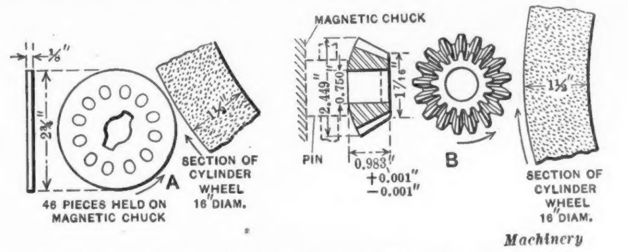


Fig. 23. Examples of Meat Chopper Disk and Bevel Pinion Surface Grinding

**A**

**Work:**—Meat chopper disk, soft steel punching, not hardened.

**Operation:**—Surface grinding both sides from the rough with an American (silicate) corundum wheel; grain 24, grade ¾; 16 inches diameter, 1½-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 13 R. P. M., finishing, 5 R. P. M.; down feed of wheel, 0.0014 inch per revolution of work-table; amount removed from each side, about 0.008 inch.

**Remarks:**—46 of these parts are held at one time on Blanchard magnetic chuck located between two retaining rings; grinding time, 4 minutes, handling time, 4 minutes; limits, just clean up; production, 345 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

**B**

**Work:**—Bevel pinion, 0.020 to 0.030 per cent carbon, open-hearth steel, carbonized and hardened.

**Operation:**—Surface grinding one end from the rough with an American (silicate) corundum wheel; grain 30, grade 1¾-W; 16 inches diameter, 1½-inch rim; speed, 950 R. P. M.—3971 feet surface speed; table speed, 6 R. P. M.; down feed of wheel, 0.0005 inch per revolution of work-table; amount removed from end, 0.010 inch.

**Remarks:**—44 of these parts are held at one time on a Blanchard magnetic chuck, being retained magnetically on pins held in a special fixture; handling time, 6 minutes; production, 200 pieces per hour; machine used, Blanchard high-power vertical surface grinder.

### Grinding Rifle Parts

The grinding of certain rifle parts can be done satisfactorily on the vertical surface grinder, because such a large number of pieces can be held at one time, and the method of holding does not require the need of special fixtures for many of the parts. This is clearly seen in Fig. 19, where 103 rifle hammers are shown held on a Blanchard magnetic chuck by simply using two retaining rings, one inside the group of pieces and one outside. This brings up a point regarding the vertical surface grinder that is worthy of attention. For a large number of parts, the surface grinder requires almost no fixtures; simple rings of sheet steel may be laid around the groups of pieces to be ground, and even if the parts are of irregular shape, it is usually possible to make a very simple magnetic fixture.

Referring to *A* in Fig. 18, it will be seen that the rifle hammer is made from a soft steel forging and is not hardened. The speed of the table is changed twice for finishing the surface. For roughing, a speed of 17 R. P. M. is used, whereas for finishing, the rotative speed of the table is reduced to 5 R. P. M. This enables the same wheel to be used for both roughing and finishing operations, and gives the desired finish.

The lever for a repeating rifle shown in Fig. 20 is another rifle part that is ground in a similar manner on the Blanchard vertical surface grinder. Fig. 21 shows how thirty-four of these parts are held on the magnetic chuck at one time. No special fixtures are required, the pieces being simply located inside a retaining ring and held magnetically to the chuck. Referring to the data shown in Fig. 20, it will be noticed that roughing and finishing cuts are taken from each side of the forgings, the roughing being done at a table speed of 17 R. P. M., and the finishing at a table speed of 5 R. P. M.; the same wheel, which is an American,

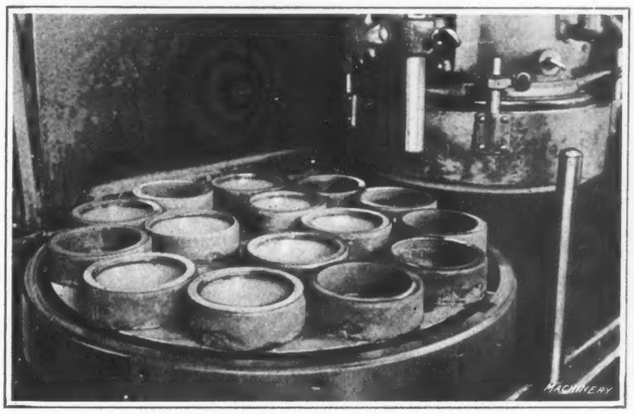


Fig. 24. Method of holding and grinding Roller Bearing Race Rings on a Blanchard Vertical Surface Grinder

(silicate) corundum wheel, grain 58-24, grade 1, being used for both operations.

### Grinding Ends of Bevel Pinions

An interesting application of the vertical surface grinder to the grinding of bevel pinions is shown in Fig. 22. The portion ground as shown at *B* in Fig. 23, is the front face which measures about 1 7/16 inch diameter. The fixture used is of interesting construction, as shown in Fig. 22, and comprises a ring *A* in which 44 steel pins *B* are inserted. The upper ends of these steel pins are turned to fit the holes in the pinions, and the latter rest on top of ring *A*. The magnetic force holds the pinions down against the top surface of ring *A*, and, at the same time, prevents them from turning on the pins *B*. In this way the pieces are held very effectively and the grinding can be done rapidly. In this case it will be noticed that the wheel is rotated at 950 R. P. M. giving a surface speed of 3971 feet, whereas the work-table is rotated at 6 R. P. M., the gear blanks being finished at one speed. The production is 200 pieces per hour.

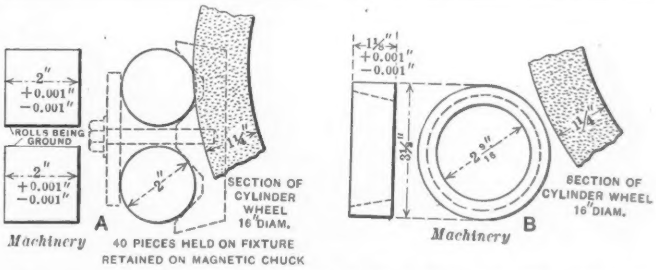


Fig. 25. Examples of Roller Bearing Rolls and Race Ring Grinding

**A**

**Work:**—Roller bearing rolls, high-carbon steel, hardened.

**Operation:**—Surface grinding both ends from the rough with a Norton (silicate) alundum wheel; grain 38-24, grade H, 16 inches diameter, 1¼-inch rim; speed, 1000 R. P. M.;—4190 feet surface speed; table speed, 17 R. P. M.; down feed of wheel, 0.0012 inch per revolution of table; amount removed from each end, 0.005 inch.

**Remarks:**—40 of these parts are held at one time on a Blanchard magnetic chuck by means of a special fixture; limits, plus or minus 0.001 inch; production, 800 pieces per day; machine used, Blanchard high-power vertical surface grinder.

**B**

**Work:**—Roller bearing race ring, high-carbon steel, hardened.

**Operation:**—Grinding both sides from the rough with an American (silicate) corundum wheel; grain 30, grade ¾; 16 inches diameter, 1¼-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed 17 R. P. M.; down feed of wheel, 0.0012 inch per revolution of table; amount removed from each side, from 0.010 to 0.015 inch.

**Remarks:**—39 of these parts are held at one time on a Blanchard magnetic chuck—no retaining ring used; limits, plus or minus 0.001 inch; production, 1500 pieces per day; machine used, Blanchard high-power vertical surface grinder.

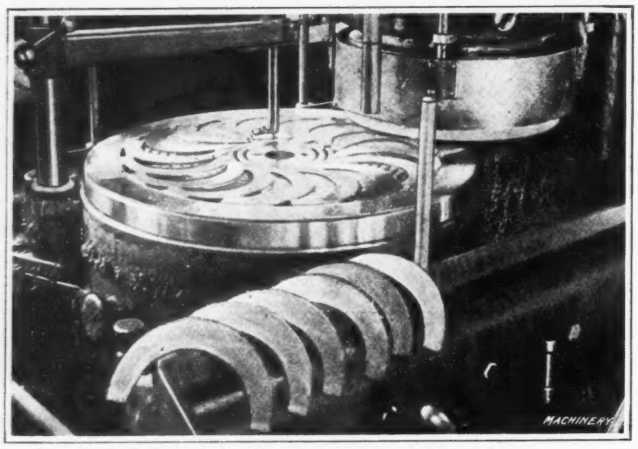

Fig. 26. Method of holding and grinding Micrometer Frames on Blanchard Vertical Surface Grinder

### Grinding Meat Chopper Disks

The meat chopper disk shown at *A* in Fig. 23 is another good example of vertical surface grinding. This disk is made from a ⅛-inch soft steel punching, not hardened; forty-six disks are held on a Blanchard magnetic chuck at one time, and are located between two retaining rings. The wheel used is an American (silicate) corundum wheel, grain 24, grade ¾; it is operated at a surface speed of 4190 feet per minute. The table speed is 13 R. P. M. for roughing and 5 R. P. M. for finishing.

### Methods of Holding and Grinding Roller Bearing Race Rings and Rolls

The roller bearing race rings shown in Fig. 24 illustrate another example of work that is satisfactorily handled on the vertical surface grinder. For the holding of these race rings, no special fixture is required. The race ring blanks are simply placed on the magnetic chuck without any retaining ring, the magnetism holding them rigidly in position. The data is given at *B* in Fig. 25.

The roller bearing roll shown at *A* in Fig. 25 is another part that is ground on both ends in a Blanchard vertical surface grinder. Forty of these parts are held at one time on a special fixture, provided with V-slots in which the rolls

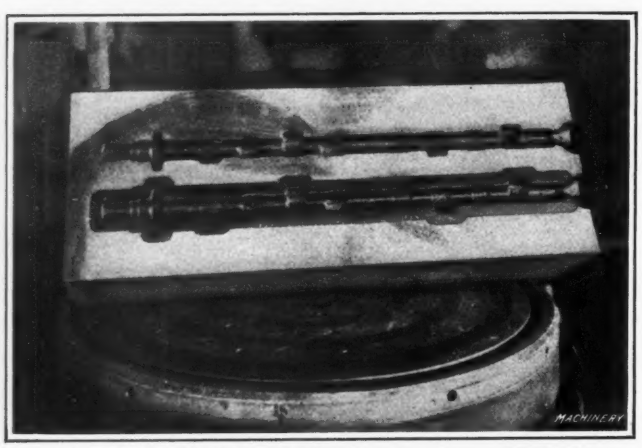

Fig. 27. Cam-shaft Drop-forging Die ground on a Blanchard Vertical Surface Grinder

are clamped by means of straps. The fixture is held on the magnetic chuck.

### Grinding Micrometer Frames

Still another example of work that can be handled efficiently on the vertical surface grinder is the micrometer frames which are punched out from soft steel. Fig. 26 shows the manner in which these are held on the magnetic chuck. By referring to this illustration, it will be noticed that they are placed inside of a comparatively broad retaining ring, but otherwise are not held, except magnetically. The wheel found to be the most satisfactory for grinding these stampings from the rough is a Norton (silicate) alundum wheel, grain 38-30, grade J, 1½-inch rim, operated at a surface speed of 4190 feet. The table speed was at the rate of 9 R. P. M., and the down feed of the wheel 0.0016 inch per revolution of the work-table. These parts were ground to a limit of 0.0005 inch, and 0.025 inch of metal was removed from each side. The production was 30 per hour.

### Grinding Face of Drop-forge Dies

The drop-forge die shown on the Blanchard magnetic chuck in Fig. 27 is a good example of tool-room work. Previous to the use of the vertical surface grinder, considerable trouble was experienced in getting the top face of these drop-forge dies perfectly flat, as they were warped considerably in hardening. This particular block is 28 inches long, 9 inches wide, by 9 inches deep, and 0.012 inch of material was removed from the top surface. Formerly the time required to grind this size of drop-forge die block was three hours, and the time was reduced to 5 minutes on the Blanchard vertical surface grinder.

### Grinding Flat and Concave Portions of Cutting-off Saws

The group of cutting-off saws shown in Fig. 29, is an example of work for which the vertical surface grinder of the rotary type is particularly adapted. As shown in Fig. 28, the saw is ground all over and in addition is made concave, nearly to the center hole to provide clearance. The flat surface of the saw is ground first on both sides; then the three-point column support of the machine is adjusted so as to set the spindle off to the desired angle to give the required concavity. The saw is again placed on the machine and both sides reground to give the amount of clearance desired. On grinding the flat portion, one saw is held at one time on the magnetic chuck. See Fig. 28 for data for the saw shown in the center of Fig. 29.

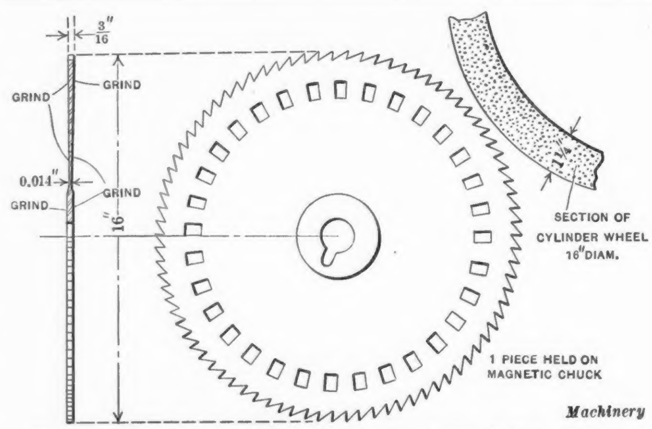


Fig. 28. Higley Type of Metal Cutting Saws ground Flat and Concave on a Blanchard Vertical Surface Grinder

**Work:**—16-inch (Higley type) metal-cutting saw, high-speed steel, hardened.

**Operation:**—Surface grinding both sides from the rough with a Norton (silicate) alundum wheel; grain 38-24, grade H; 16 inches diameter, 1¼-inch rim; speed, 1000 R. P. M.—4190 feet surface speed; table speed, roughing, 8½ R. P. M., finishing, 5½ R. P. M.; down feed of wheel, 0.0016 inch per revolution of table; amount removed from each side, 0.015 inch; four operations—two for flat and two for concave grinding.

**Remarks:**—One of these parts held at one time on Blanchard magnetic chuck; grinding time, 8 minutes; handling time, 3 minutes; limits, plus or minus 0.002 inch; production, 6 per hour; machine used, Blanchard high-power vertical surface grinder.

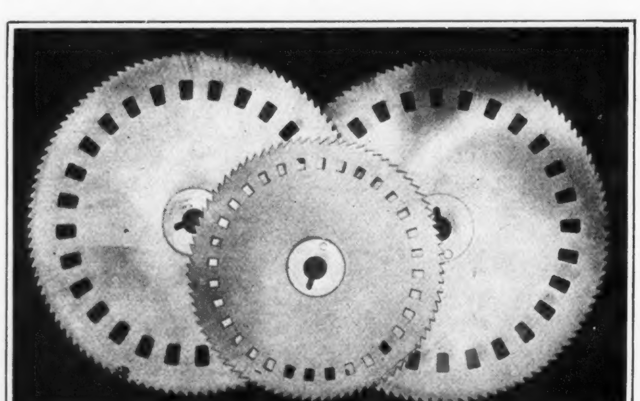

Fig. 29. Example of Saws ground on Both Sides Flat and Concave on Blanchard Vertical Surface Grinders

## DON'TS FOR TOOL DESIGNERS*

BY EDWARD J. UTZ†

Don't design without a system.

Don't draw a tool to any other scale than full size.

Don't use screw drill bushings.

Don't forget that two operations may be cheaper than one.

Don't forget it is harder to actually make the tool than to design it.

Don't use dowel pins where cast-iron backing is available.

Don't forget that all wearing parts should be easily duplicated.

Don't put cast-iron bosses on wearing surfaces which are of importance.

Don't use too many screws and levers on your design.

Don't forget that certain parts of the tool must be cleaned after each operation.

Don't put springs and levers or any moving part on the tool where the chips will fall on them, unless they are properly covered.

Don't forget that many drill press tables and surface plates in actual practice are not true.

Don't design point bearings on jigs and fixtures which have to lie on drill press tables, etc. A two-line contact is better.

Don't design a tool until you have studied the conditions under which it has to work. By so doing, you will save time and money.

Don't design an elaborate tool when something plain and inexpensive will do the work.

Don't forget that nine out of every ten tools are never duplicated; therefore take pains to design as efficient a tool as possible.

Don't design a tool that cannot be cleaned effectively in the least possible time.

Don't forget that many operators are unskilled men and very cheap labor.

Don't give a toolmaker a drawing full of decimals; remember, he can gage 2 inches more effectively by standard gages than 1.985 inch.

Don't design parts to be countersunk; they cost money.

Don't forget to use patternmakers' dimensions very sparingly, as they are of no use to the toolmaker.

Don't design sharp corners on any part of the tool.

Don't forget that cores on jigs and fixtures are expensive, and by careful design they may be eliminated. Show all drafts on your design, and show which way you wish to have it cast.

Don't dimension a flat on a round piece from the center; always give the size from the outside diameter to the flat.

Don't forget that drill bushings below ⅝ inch in diameter cannot be ground; they must be lapped.

Don't design drill bushings that are too thin and too short.

Don't forget that the ends of all screws must be round for rough work and flat for finished work, and that they must also be casehardened.

Don't forget that in accurate drilling all holes must be reamed.

Don't allow more than 0.002 to 0.010 inch for reaming. Always drill and ream in the same jig by the use of slip bushings.

Don't hold a slip bushing in any way; let it slide freely in the master bushing.

Don't design collars on drill bushings; they are of no use to any one and cost money.

Don't forget that all bushings over 1 inch outside diameter can be made of machine steel, pack-hardened and ground.

Don't design a tool in such a way that you must drill against a screw; such a construction is not reliable. Always use a clamp.

Don't use a thumb-screw where a set-screw is needed.

Don't design loose parts on jigs and fixtures; they are apt to be lost and it will cost a lot of money and time to replace them.

Don't design gaging points where they will affect the efficiency of the operator.

Don't design heavy jigs and fixtures; a little figuring will convince you as to the strength of materials.

Don't forget that each motion that is required on your tool has to be duplicated on each piece, costing time and money. In designing gaging points always have them in even figures such as ¼, ½, ¾ inch from the part to be machined. Always use machine steel for gaging parts, and have it casehardened and ground to size.

Don't depend upon springs to operate parts of a mechanism.

Don't design cams on jigs and fixtures; they cost money and are not reliable.

Don't forget that standardization of screws, bushings, thickness of walls, size of clamps and studs will prove a great time saver not only to you but to all the factory. Adopt standards which are far-reaching and easily understood; and always look for improvements on your standards. Do not be satisfied with something simply because it works.

Don't forget that two ideas are better than one; therefore, if there is something that you don't like, call it to the attention of the chief and talk things over with him.

Don't forget that it is easier to erase a screw or change its position on a design than it is after the casting is made. Always design the tool as if you were going to make the pattern and the casting, and had to do the machining and finally the operating. Always remember that the tool designer is responsible for the profit of the manufacture. Efficiency of the tool means manufacturing profit.

Don't forget that your requirements are large; therefore keep up with all the latest technical journals; not only read them but study them.

Don't forget that in your design many parts such as screws, clamps, etc., should only be shown on two views.

Don't forget that it is easier to make a free-hand sketch to get an idea if your plan will work than to start on the drawing board, and finally have to throw the whole design away.

* For additional "Don'ts" published in MACHINERY see also "Don'ts for Ball Bearing Users," July, 1914; "Don'ts for Drilling Machine Operators," November, 1913; "Don'ts for Draftsmen," September, 1913; "Don'ts for Drill Grinders," July, 1913; "Don'ts for the Manager," November, 1912; and "Don'ts for Toolmakers," December, 1911.

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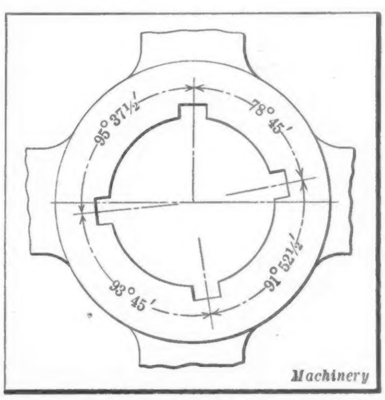
* * *

## SETTING TIMER GEARS ON THE FRANKLIN CAR

At the H. H. Franklin Mfg. Co.'s factory in Syracuse, N. Y., where the Franklin car is manufactured, the operation of setting timer gears either in the factory or outside is greatly facilitated by broaching the timer gears with irregularly spaced multiple keyways at the time of manufacture. The illustration shows the positions of the four keyways that are broached at varying distances in the timer gears, both the gear on the magneto and that on the camshaft being similarly treated. It will be readily appreciated that with the option of setting the timer gear at any of four designated positions on the shaft, each of which gives slightly different timing, the proper adjustment is easily made.




Four Irregularly Spaced Keyways in Timer Gears to facilitate Setting

Especially does this feature prove valuable to the car owner who has broken a timer gear and orders a new one from the factory. He has no trouble in locating the gear on the shaft, nor is it necessary to mark the gear for any particular position and have a keyway especially cut, for out of four possible positions, one is sure to give correct timing. Moreover, this advantage does not add appreciably to the manufacturing cost of the car. C. L. L.

# RECTANGULAR DRAWING AND TRIMMING*

## LAYING OUT RECTANGULAR DRAWING DIES—DETERMINING NUMBER OF OPERATIONS—TRIMMING DRAWN PARTS

BY JOSEPH M. STABEL†

THE drawing of rectangular shapes does not seem to be understood by many tool- and die-makers as well as cylindrical drawing, which is doubtless due to the fact that rectangular dies are not as common as those used for drawing cylindrical parts. Consequently when a rectangular die is to be made some experimental work is usually required, although much of this could be eliminated if certain fundamental points in regard to rectangular drawing were understood. The writer will endeavor to explain some of the points which experience has shown are essential to success.

### Shape of Drawn Part and Points to Consider when Selecting Material

The first thing to consider is the design or shape of the part to be drawn. This is often overlooked by the designer, as all he may have in mind is to produce a box of a certain size. Therefore he may specify a radius of 1/8 inch at the corner of this box when the radius could just as well be 1/2 inch, and perhaps the radius at the lower corner could also be larger than is specified. This matter of corner and edge radius is important and may greatly affect the drawing operation. The kind of metal to be used should also be considered. It is often more profitable to make small parts of brass than of steel because there is less wear on the dies and fewer spoiled parts. When steel is to be used and the depth of the draw exceeds one-half the width of the box, a "deep drawing" steel should be used. A deep drawing steel which has proved satisfactory contains from 0.08 to 0.18 per cent carbon (preferably about 0.10 to 0.12 per cent); about 0.35 per cent manganese with less than 0.03 per cent phosphorus and sulphur. It is advisable to be on the safe side when deciding what thickness of metal to use; that is, it is preferable to use a little extra metal and have ample strength at the lower edge of the box where the greatest strain from drawing occurs, than to use a metal that is barely strong enough to withstand the drawing operation. This is especially true if the part must be drawn to considerable depth. When using brass and aluminum, the cost of the material is an important factor and it is common practice to begin with stock, say, 1/32 inch thick; the original thickness is retained in the first draw, but is reduced in each succeeding draw so that when the box is finished the sides will be considerably thinner than the bottom. With this method, less metal may be used or, in other words, a smaller blank than if the box were made of uniform thickness. The reduction of thickness at each draw should not exceed 0.0025 inch on a side. Thinning the sides in this way is not considered practicable when using steel, owing to the comparative cheapness of steel and the increase in wear on the dies which would result.

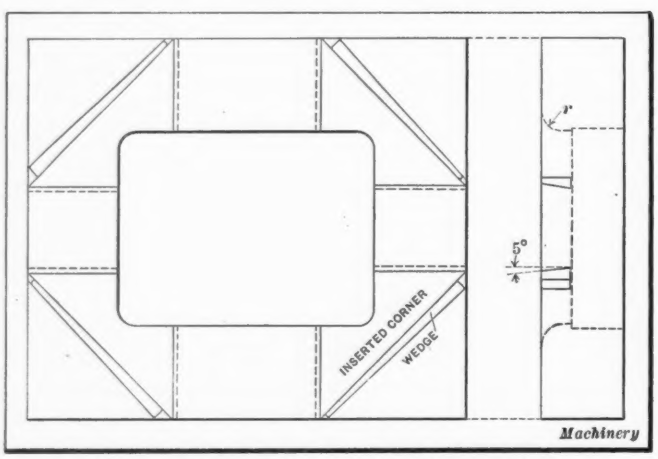



Fig. 1. Rectangular Die with Inserted Corner Pieces

### Laying Out Rectangular Dies

After having carefully considered the design of the part to be drawn and the material from which it is to be made, the next step is that of laying out the die or dies. as the case may be. There are several fundamental points that should be considered before proceeding with the laying-out operation. For instance, there may be some doubt as to the practicability of drawing a box in one operation, and one might naturally suppose that by employing two operations many difficulties would be avoided, because the work is divided between two dies. There may be more trouble, however, when using two dies, especially if steel is to be drawn, because the drawing operation is confined to the corners, and forming the sides of the box is nothing more than a folding or bending operation; consequently the wear of the dies is in the corners, and as the result of this wear and increase of clearance space the metal thickens at the corners. In some cases the metal will thicken to such an extent as to make it impossible to push the work through the second die when two are employed, without rupturing the box at the corners. Moreover, when there are two operations, annealing may be required between the draws, and if this is done in an open fire, oxidation takes place which would require a pickling operation to free the part from scale. Even though a closed furnace is used, the parts should be washed to free them from grit, as otherwise the die would be lapped out very quickly. If there is no doubt as to whether a box should be made in one die or two, it is advisable to first make the finishing die and attempt to produce the part in one operation. If this trial draw shows that one die is not practicable, then the first-operation die can be made.

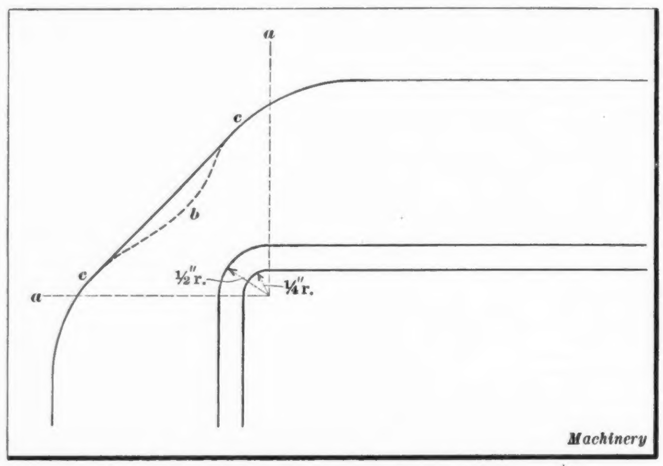



Fig. 2. Outline of Blank, and Drawn Boxes of Different Sizes and Corner Radii

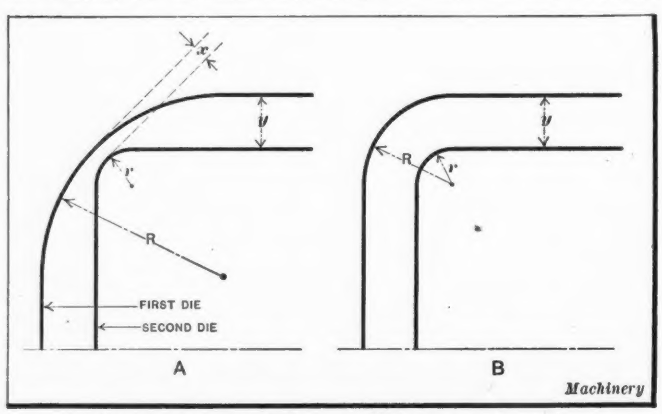



Fig. 3. Correct and Incorrect Methods of laying out First-operation Die

* For additional information on dies, see the following articles previously published in MACHINERY: "Automatic Indexing Multiple Drawing Die," July, 1915; "Deep Drawing in Combination Dies," April, 1915; "Dies for Drawing Flanged Shells," March, 1915; "Press Tools for Making a Roller Bearing Cage," March, 1915; "Formulas for Blank Diameters of Drawn Shells," January, 1915; "Edge Radius of Drawing Dies," October, 1914; "Sub-press Dies for Armature Manufacture," July, 1914; "One-piece Armature Disk Tools," March and January, 1914.

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The amount of clearance at the corners is another important point. By allowing a little more than the thickness of the metal between the punch and die at the corners, the pressure required for drawing is considerably reduced. For instance, if stock 0.0625 inch thick were being used, a space of about 0.067 inch should be left at the corners; this clearance is advisable for a one-operation die and also for the final die of a series. The top surface of a first-operation die should be perfectly flat and smooth. If this surface is ground, the grinding marks should be polished out, as otherwise the pressure of the blank-holder will tend to hold certain parts of the blank more than others, causing an uneven draw.

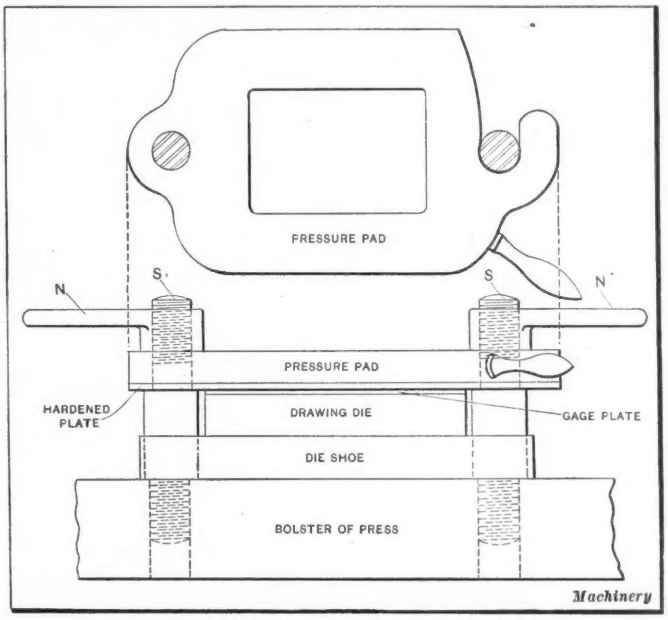


Fig. 4. Simple Design of Rectangular Drawing Die

The corners of the die, as well as the punch, should be made very hard. The writer has used a die equipped with inserted corner pieces, as shown in Fig. 1. This form of die was designed for drawing a large number of steel parts, 6 by 8 inches in size, and up to the present time the sides have outworn at least six sets of corner pieces, not counting the number of times these pieces have been reworked. This construction allows the corners to be made much harder than if they were part of a solid plate. It also permits the use of expensive steel, such as high-speed steel, for these corner pieces, as they are small in comparison with the rest of the die. This form of die is not recommended for small work.

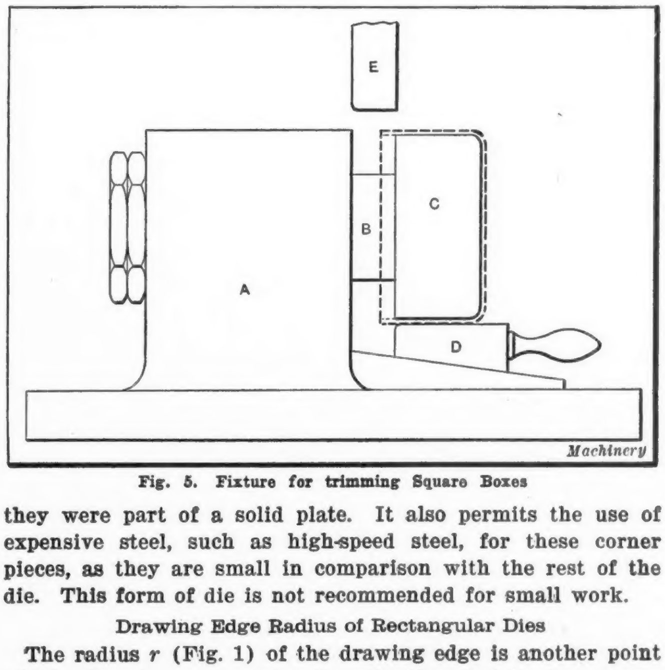


Fig. 5. Fixture for trimming Square Boxes

### Drawing Edge Radius of Rectangular Dies

The radius *r* (Fig. 1) of the drawing edge is another point which often does not receive the attention that its importance merits. In the first place, this rounded surface should be uniform and smooth. The edge radius of the first drawing die (assuming that more than one operation is required) is the most important. Theoretically, this radius should be as large as possible, but it is restricted for the reason that the larger the drawing radius the sooner the blank is released from under the blank-holder or pressure pad, and if this release occurs too soon, the metal will wrinkle; wrinkling of the metal will cause a fractured corner.

It is also important to make the corner radius as large as possible. Fig. 2 shows, in part, the outline of a blank and also corners of ¼ and ½ inch radius, respectively. The dotted lines *a–a* indicate the metal in the blank which must be folded up and compressed into a corner. When the corner radius does not exceed ¾ inch, the radius of the drawing edge of the first die should be about the same as the corner radius, whereas for a corner radius exceeding ¾ inch, the drawing edge radius of ¾ inch should be retained.

### Determining Number of Drawing Operations—Corner Radius

In laying out rectangular dies, naturally one of the first things to consider is the number of operations required to complete the box or whatever part is to be drawn. The number of operations is governed by several factors, such, for instance, as the quality of material, its thickness, the corner radius and also the radius at the bottom edge of the drawn part. In some cases, this lower edge can be rounded considerably, whereas in others it must be nearly square. Obviously, when the corner is sharp a fracture at this point is more likely to occur, owing to the pull of the drawing punch. Because of these variable conditions no definite rule can be given for determining the number of operations, although the following information will serve as a general guide.

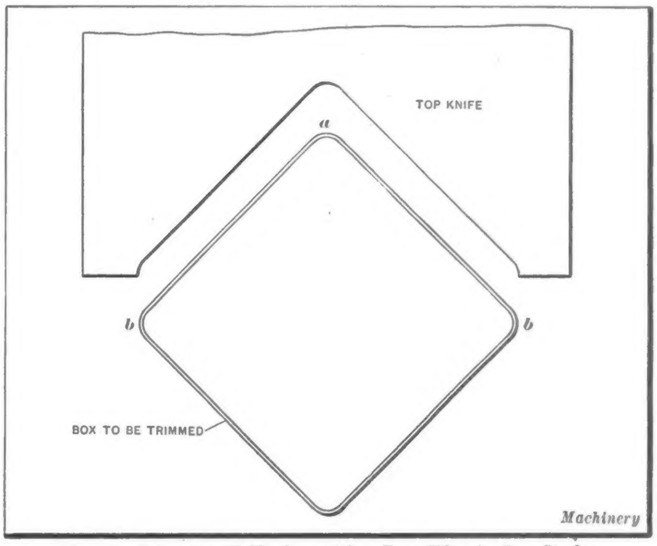


Fig. 6. Trimming Knife for cutting Two Sides in One Stroke

When drawing brass, it is safe to assume that the part can be drawn to a depth equal to six times the corner radius. This rule has been applied to all radii not over ¾ inch. For rectangular parts having larger corner radii, the depth would be somewhat less than six times the corner radius. Suppose a box is to be drawn that is 5 inches wide, 6 inches long and 3 inches deep, and that the corner radius is ½ inch, and the lower edge rounded to about ¼ inch radius. By applying the foregoing rule we find that this can be done in one operation; thus, the depth equals six times the corner radius, or $6 \times \frac{1}{2} = 3$ inches. If the corners were of ¼ inch radius, then two operations would be required.

When two dies are required the first die should have a corner radius equal to about five times the radius of the finished part. The relation between the corners of the first and second dies is indicated by the diagram *A*, Fig. 3. As will be seen, they are not laid off from the same center but so that there will be enough surface $x$ between the two corners to provide a drawing edge. The reason for selecting such a large corner radius for the first die is that when these large corners are reduced to the smaller radius in the second die a large part of this compressed metal is forced out into the sides of the box. Now if the first die were laid out as indicated at *B* or from the same center as the second die, there would be a comparatively large reduction at the corner and, consequently, the metal would be more compressed and the drawing operation made much more difficult, because, as previously mentioned, the drawing action is confined to the corners when drawing rectangular work. Sometimes dies are

made as indicated at *B*, but the reduction necessary in the second operation is likely to result in fracturing the metal. The radius of the first die should be laid out from a center that will leave a surface *x* (see sketch *A*) about $\frac{1}{8}$ inch wide, although this width should be varied somewhat, depending upon the size of the die.

The amount *y* that a rectangular part can be reduced between draws depends upon the corner radius and diminishes as the corner radius becomes smaller. For instance, a box with corners of $\frac{1}{8}$ inch radius could not be reduced as much as one with corners of $\frac{3}{8}$ inch radius. To obtain the total amount of reduction, or $2y$ (see Fig. 3), multiply the corner radius required for the drawn box by 3 and add the product to the width and length, thus obtaining the width and length of the preceding die. This rule should only be applied when the corner radius is less than $\frac{1}{2}$ inch. For all radii above $\frac{1}{2}$ inch, simply multiply the constant 0.5 by 3 in order to obtain the reduction. Suppose a box is to be drawn that is 5 inches wide, 6 inches long, $\frac{1}{8}$ radius at the corner, and we desire to establish the size of the first-operation die. By applying the rule just given, we have $\frac{1}{8} \times 3 + 5 = 5\frac{3}{8}$ inches, and $\frac{1}{8} \times 3 + 6 = 6\frac{3}{8}$ inches. Therefore, the die should be made $5\frac{3}{8}$ inches by $6\frac{3}{8}$ inches. As previously mentioned, the corner radius for the first-operation die should be about four times the corner radius of the finished part; hence the radius in this case would equal $\frac{1}{8} \times 4 = \frac{1}{2}$ inch. In this way, the number of operations required to draw a rectangular part is determined.

### Shape of the Blank

After the drawing dies are completed, the shape of the blank must be determined. While a blank can be laid out which would be of approximately the required shape, the exact form must be determined by trial before the blanking die can be made. (A good method of laying out blanks for rectangular parts was described in the April number of MACHINERY, page 687.) The proper way is to first lay out the blank and then cut out two blanks so that after one has been drawn the other can be changed as may be found necessary. When laying out the blank, it is often advisable not to attempt to secure a shape that will form corners that are level with the sides of the drawn part, but rather a form of blank that will produce corners that are a little higher than the sides. This is desirable for two reasons: In the first place, as previously mentioned, the wear on the die is at the corners, and when wear occurs the metal will thicken and then the drawn part will be low at the corners, provided no allowance is made on the blank. Second, the shape of the blank for drawing an even level corner would often correspond somewhat to that indicated by the dotted line *b* in Fig. 2, and the tendency of the high projections *c* would be to carry the metal toward the corner and cause a seam, due to the low part *b*. Incidentally, a burr along part of the blank edge often causes trouble, because it tends to hold that part of the blank tighter under the blank-holder than the remainder, thus causing an irregular shape.

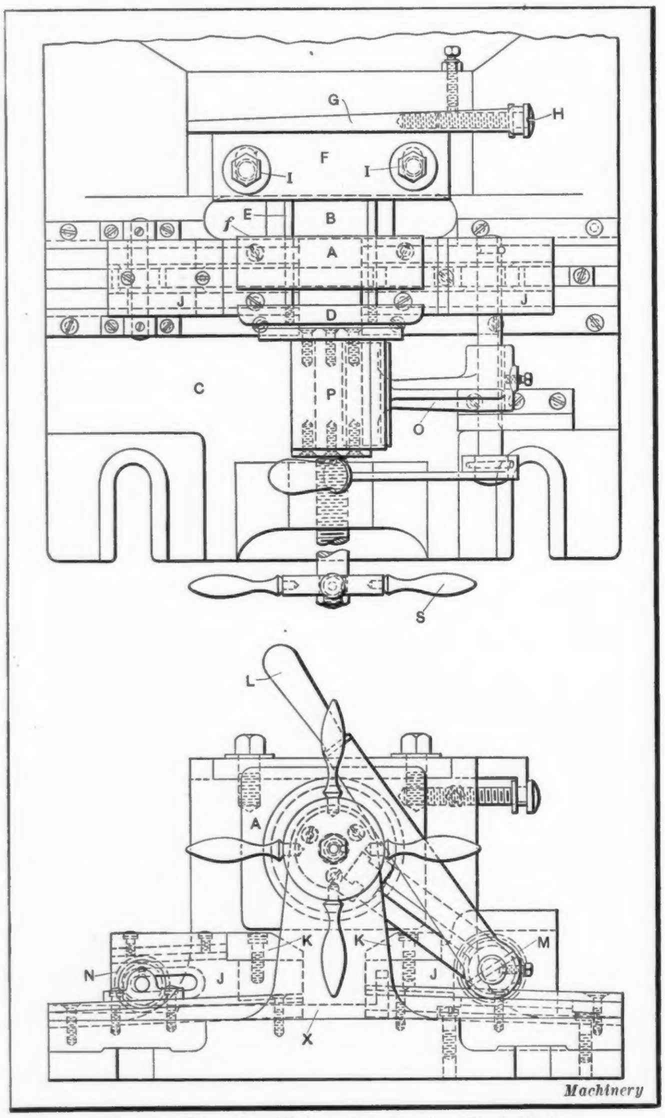


Fig. 7. Trimming Fixture for drawing Steel Parts

### Type of Die for Use in Single-action Press

Many are of the opinion that a double-acting press is necessary for this kind of work unless the drawn part is shallow and a combination die is used, but this is not the case. A single-acting press which is geared for reduced speed will serve the purpose, and a simple type of die may be employed. The speed, however, should not exceed 60 revolutions per minute. The greatest difficulty connected with the use of a single-acting press is the arrangement of the blank-holder or pressure pad. This can be made in several ways. One method is to attach the drawing die to the ram of the press and the punch below in the die-shoe with the pressure ring extending around the pnnch and resting on pins that pass through the shoe and bear against a plate which is backed up by a rubber buffer or spring pressure attachment that can be adjusted to give the pressure required. This arrangement is satisfactory for many classes of work, but when drawing comparatively deep parts it is objectionable in that the blank-holder pressure increases as the die descends; consequently, if this pressure is sufficient for the beginning of the drawing operation, it will be excessive at the end of the downward stroke. This defect is sometimes remedied by using extra long springs or buffers, or a special "compensating attachment." For deep drawing, when a single-acting press is to be used, the writer prefers a die equipped with a pressure pad of the type shown in Fig. 4. The die and die-shoe rest upon the bolster of the press and into the latter are screwed two shoulder studs *S* having coarse threads onto which are fitted the handled nuts *N*. These nuts serve to hold down the pressure pad which is pivoted on one of the studs and slotted to receive the other so that it can be swung out of the way. (See plan view.) The under side of the pad is faced with a hardened tool-steel plate $\frac{1}{4}$ inch thick. When using the die, the pressure pad is swung out, the blank placed in position, and then the pad is swung back and tightened by nuts *N*. After a few parts have been drawn, the operator will be able to determine how much these nuts should be tightened to prevent wrinkling. The heavier and more rigid the studs and pad are, the less tightening is necessary, because the object is simply to confine the metal before it goes into the die so that wrinkling will be impossible. This form of die has proved satisfactory and it is similar in effect to the action of the double-acting press. A vent hole should never be omitted in the drawing punch, as this facilitates stripping the drawn part.

### Trimming Drawn Rectangular Parts

After a square or rectangular part is drawn, it is necessary to trim the edges unless the depth of the draw is comparatively small, as in the case of can or box covers, etc. There are several ways of trimming the edges in a punch press. If the box is square it can be placed on a fixture of the type shown in Fig. 5 and be trimmed by cutting the four sides successively, the work being indexed by turning spindle *B*. Each cut should overlap the other by a small margin to in-

sure a smooth even edge. The spindle *B* is a running fit in the main casting *A* and holds the hardened tool-steel knife *C*. The dotted lines show the position of the box to be trimmed. As shown, a tapered wedge *D* which slides in under the lower side of the box serves to locate the box and also to take the downward thrust of the cut. The blade or knife *E*, which is attached to the ram of the press, may be ground square across the end or at a slight angle on the cutting face; a slight amount of angle or rake is desirable when trimming thick stock. If the part to be trimmed is rectangular, the length of the knife should be equal to the length of the longest side of the box minus the radius of one of the corners. For instance, a box 5 by 6 inches having a ½-inch corner radius should be trimmed with a knife 5½ inches long. The two long sides should be cut first because if the short sides were cut first, there would be a tendency to distort the corners. When the sides are unequal, the wedge *D* should either be double-ended or have enough taper to compensate for the difference in the box dimensions.

Another method of trimming is shown in Fig. 6. In this case, two sides are cut simultaneously so that only one indexing is required. This method is satisfactory for soft metal such as brass or aluminum, but is likely to cause trouble when trimming steel, because the corners are so hard as the result of drawing that the top corner *a* might split from the strain of the cut, unless the box were annealed for trimming.

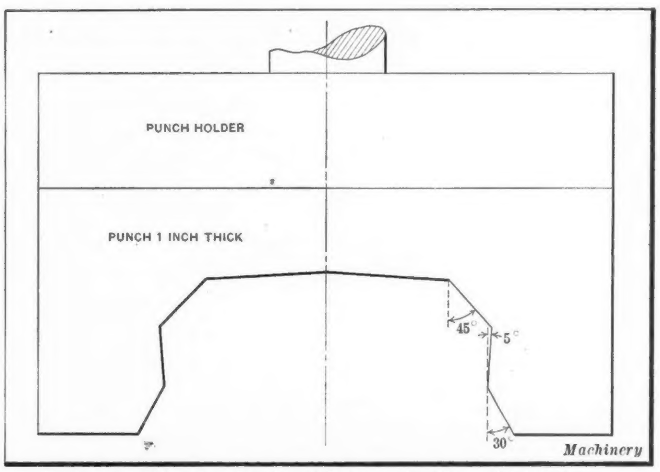


Fig. 8. Trimming Punch used in conjunction with Fixture shown in Fig. 7

The fixture for indexing and supporting the work is similar to that illustrated in Fig. 5.

To avoid making four cuts when trimming steel parts, and also to obviate annealing, the special trimming die shown in Fig. 7 was designed. This die has been in use for the past seven years and has trimmed thousands of boxes each year. It has a lower knife *A*, held by spindle *B*, which is a running fit in a bearing at the rear of the main body casting *C*. The box to be trimmed is placed over knife *A*. Spindle *B* is held in position by nuts (not shown) and has a ¾-inch knockout rod extending through it which acts upon a knockout pad *D*. This pad also serves as a stop-gage for regulating the depth to which the box is trimmed. A fixed length is retained irrespective of how much knife *A* is ground. Four pins *E* are screwed into the pad and pass through holes in knife *A*, resting against the face of a hardened bushing in the casting. This allows the face *f* of the knife to be ground repeatedly because knife *A* rests against the shoulder on spindle *B* and pins *E* hold pad *D* stationary. The knockout rod (not shown) is actuated by a series of levers connecting with a handle at the left of the operator. The hardened plate *F* is for taking the thrust of the top knife which is held in the punch-holder. This plate is secured by cap-screws *I*, and it can be adjusted by screw *H* and wedge *G* to compensate for sharpening the top knife. The two slides *J* which have hardened faces *K* slide underneath the box and serve to locate it in position, and also support it rigidly against the thrust of the cut. These slides are operated by lever *L* through pinions *M* and *N*. Pinion *M* has its bearing in the right-hand slide and engages a stationary rack beneath it. Attached to the right-hand slide *K* is an extension *X* having rack teeth which mesh with the pinion *N* mounted in a stationary bearing. This pinion, in turn, meshes with a rack above it attached to slide *K*. Thus it will be seen that a movement of lever *L* from right to left causes both slides *K* to move in under the box to be trimmed. This same movement of the lever also moves arm *O* and slide *P* into position for clamping the bottom of the box, the clamping being effected by pilot wheel *S*, which is attached to the screw shown. With this arrangement only a small movement of the screw is required, and when lever *L* is thrown to the right and the distance block *P* is removed there is plenty of space for taking out the trimmed box and inserting another. A detailed view of the trimming knife or punch is shown in Fig. 8. Considerable experimenting was necessary before securing a trimming punch that was perfectly satisfactory. The edge having a 30-degree angle on each side shears the side of the box down a little beyond the center; the 5-degree edge provides the necessary clearance; whereas the 45-degree section cuts out the round corners of the box, after which there is a slight shearing cut to the center.

* * *

## TRAINING OF SHOP TEACHERS FOR INDUSTRIAL SCHOOLS*

In dealing with the subject of the training of teachers for industrial and trade schools, there are two general classes that must be recognized, depending upon, or resulting from, the two general sources from which such teachers come. These sources are the trained academic teacher and the trained mechanic. There is a division of opinion as to which source furnishes the better type of teacher. There are those who believe that the primary requisite of such a teacher is the ability to grasp the educational value of a subject, and to deal with and give instruction to the learner. These hold that pedagogical training is the basis upon which must be placed enough knowledge of the subject to enable the teacher to meet the problems of the school shop. There are others that believe that, since it is industrial training that is wanted, the essential things are the industrial atmosphere, methods, and standards of efficiency. These hold that any mechanic of a degree of intelligence to become a candidate for a teacher's position can be trained sufficiently in methods of instruction to make him the better type of shop teacher. Of course the ideal shop teacher is the one who is thoroughly trained in both phases; but since a thorough training in either involves several years of time and study, we are likely, at the present salary schedule, to have to choose between the two types.

To discuss the ability of the mechanic teacher it is necessary to establish the rank in the industry from which the average candidate comes. Shop instructors are generally recruited from the ranks of journeymen. Some of these have only a common school education, a few have high-school education, but none of them are college men. This statement would hold in general for all apprenticeship schools established by railroads and factories. In the public schools the situation is slightly different, with probably a little more inducement for the man of higher rank to enter. Yet, just as the railroad shops or factories cannot take their foremen to teach the apprentices, so society cannot take trained foremen as teachers in public industrial schools. In other words, industry outbids the public schools for such men. Dr. Snedden, probably the one most influential in the demand for the mechanic teacher, says that the rank of foreman is preferable, but recognizes that he can only demand that of journeyman.

To those of us who know the present method of commercial production and the lack of apprenticeship in the industries, the requirement of journeyman standing does not insure ability. The journeyman is usually the victim of the factory system or the contractor's policy of keeping him at the one special job which he can do best. He might be highly skilled in laying floors, shingling, lathing, framing,

* Abstract of article by Harold E. Speece in the "Manual Training Magazine."

stair building, or some other specialty, but not have a general training in carpentry. He might be a specialist in some phase of machine work, but we have heard lately, from Mr. Ford, that it takes only two weeks to train a specialist.

Observation seems to show that the candidate is usually a young handy man of a high degree of intelligence, who has been earning his living at some form of the work he intends to teach, and who is dissatisfied with the social position of a worker in his trade, and desires to make more money per year and have a summer vacation.

### Strong Points of the Mechanic Teacher

1. He can do good work himself. This gives him a confidence in demonstration, and gives the boys a confidence in him that is invaluable. There seems to be to us all, and especially to the boy, a strong appeal in the ability to do things with the hands.

2. He can apply commercial standards. Most of our school shop work falls below commercial standards for two reasons: First, the workers are only of apprenticeship rank; and second, the teacher does not know the commercial construction which they would be able to use. Also, the element of time does not enter into school shopwork, and only a trained mechanic knows how to appreciate this.

3. He can create a shop atmosphere. An atmosphere is the most intangible, elusive thing in the world, and yet it is the most influential. A school boy changes from a careless, indifferent piddler to an earnest, zealous workman with a change of atmosphere, and yet one could see no concrete thing that he could say, "That is it." Perhaps the air of quiet confidence in the ability to turn out work that is worth while gives the boys the same confidence.

4. He is in sympathy with the labor element of society. One of the large features in the training of the worker of today should be the giving of an outlook on life and social problems that would rescue him from the agitator. This would mean constructive leadership by the teacher in the affairs of citizenship and social conscience. This could best be done by the mechanic, because the problems of labor today must be solved by the friends of labor, otherwise there will be no solution. The trained academic teacher is usually not wholly in sympathy with the labor element, because he is a product of a selective institution, deals largely with abstractions, and is more interested in teaching the traditional past than the progressive present.

5. He can give the student correct guidance as to desirability, opportunity, and dangers of the trade in question; in other words he is a better authority on that vocation, having followed it, than the trained pedagogue who has read about it. This vocational guidance is also one of the large functions of the industrial school teacher of the future. Statistics show that only a small percentage of the pupils really follow the vocation for which they train in trade schools. So we must make the schools more than ever a trying-out place, and save some of the misfits if we can.

### Weak Points of the Mechanic Teacher

1. He does not understand teaching principles. In the learning process there are certain fundamental laws and principles. These laws and their operation are the subject of years of study and training for the teacher, and it would be too much to assume that a worker who had spent no thought upon the subject would not suffer in comparison in this field. We are all familiar with the mechanic teacher who makes the jigs, sets the machine, gives the finishing polish, and makes a splendid exhibit. On the other hand, these laws are not so occult that the intelligent person desiring to impart knowledge or training to a pupil cannot by good sense accomplish largely what he intends, without having heard of one of them. Also, he is dealing with pupils who will not recognize if they are the victims of poor pedagogy, while ofttimes they would recognize quickly if the teacher did not use correct shop methods.

The laws and principles of teaching should be one field of training for the mechanic candidate. The teacher must be able to recognize the stage of progress of the learner and be able to carry him forward in sequence. He must recognize that while the learner consciously controls the stroke of the hammer, he is quite as likely to hit his thumb as the nail; that it is the subconscious control that brings skill in operations; that it is one thing to do a thing well, and quite another to tell just what coordinations are necessary to bring the result. He must recognize that training in trade processes is not necessarily education, but may be made the basis and motive for education. He must recognize the value of initiative and resultant satisfaction on the formation of habits, and a few other things like these, before he is prepared to stand before a class to teach.

2. He does not understand scientific management. The urgent demand for better organization and more scientific management everywhere concedes that the standards of efficiency are not so generally recognized as we are sometimes led to believe. Why are not the skilled trades more highly organized and systematized than the unskilled? When organization and system are introduced into an industrial plant today, it is not the trained mechanic who is called in to establish the system; it is usually the specialist, a college man. This means merely that the college man is of a more highly selected group, with greater capacity for organization.

3. He cannot grasp new problems or problems outside his own specialty like the teacher. In one case a machinist of many years' experience and a technically trained teacher came upon the problem of a change-gear box, where by shifting three levers it was possible to get sixteen changes of speed. After a glance at the instructions the teacher could make any desired change instantly, while the mechanic had to go over and over the operation until it became a part of his experience. This is only one "robin," and does not make it spring, but according to observation, the more highly selected and trained group of teachers will be able to duplicate these results in most new situations.

4. In administrative capacity he is likely to over-emphasize his own trade. In a prominent high school there is what seems a decidedly one-sided equipment and over-emphasis of machine work. There, in an equipment costing one hundred twenty-five thousand dollars, one-half of it went to the machine work alone. The pattern shop, foundry, and mechanical drawing rooms were simply auxiliary departments to the machine shop. All other trades commonly taught in school were ignored.

### Training the Teacher

The strengths and weaknesses of the academic teacher candidate have been given by inference in contrast to the weaknesses and strengths of the mechanic candidate. All things considered it seems that the weaknesses just about balance the strength of each. Why then is the weight of sympathy of the organizer today toward the mechanic candidate? Is it not because of the methods of training the teacher candidate? The mechanic frankly accepts the fact that he must study, and spend good time and money, before he can accept a position, and then he usually goes in as assistant, while the teacher candidate heretofore has been accepting positions without further preparation than the study of classroom methods of a slightly different kind. The trouble has been that we have been giving both classes of candidates exactly the same type of training, while their previous experience demands opposite kinds of training. The mechanic candidate needs the theory and practice of teaching and classroom management. The academic candidate needs the actual participation in the production in the line he proposes to teach. Let him count the difference in wages in shop and his school salary as the price he pays for training for a new and better paying position. What he should do is frankly to accept the fact that this is a new field of knowledge to him, and that he must study in this field by actual participation. With the addition of this experience he will become, because of more rigid selection, the better type of teacher.

The conclusion then is that if the demands of an organizer of a school system were such as to bring two classes of candidates, one class with five years experience as mechanics and one year as teachers, and another class with five years experience as teachers and one year as mechanics, the better type of teacher would be found in the second class.

## VALVE PART MANUFACTURING ON A BENCH LATHE

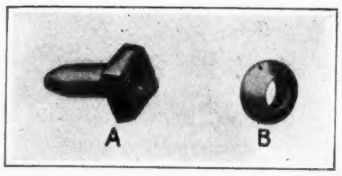

Fig. 1. Valve Parts made on a Bench Lathe

The two small parts shown in Fig. 1, and in detail in Fig. 2, are used in a newly designed pneumatic valve. These pieces are shown greatly enlarged in Fig. 2, the actual size being less than ½ inch long for the larger part, and ¼ inch diameter for the smaller hemispherical part. Both pieces are made of steel. The production required was not sufficient to warrant tooling up a screw machine and milling machine, and yet the output was large enough so that it would not be economical to make them up without special tools or fixtures of any kind. The Rivett Lathe & Grinder Co. of Brighton, Boston, Mass., recently completed the tooling up of one of its lathes for producing the parts, using its regular turning, milling and grinding fixtures. No special attachments of any kind were used; and this shows what can be done with standard equipment when properly used.

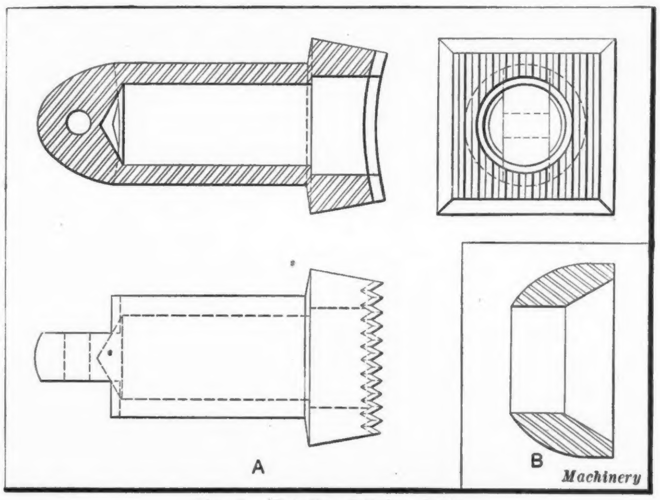

Fig. 2. Details of Valve Parts

Taking first the piece designated as *A*: this is made of cold-rolled steel, and the first operation consists in gripping the 11/32-inch round bar stock in the collet chuck while it is formed with a circular forming tool held on the forming tool-slide, as shown in Fig. 3. At the rear side of the slide a set-screw may be seen that limits the cross travel of the slide to the point, which leaves the finished diameter 0.150 inch. After this piece has been formed, the cutting-off tool mounted at the rear side of the slide is brought in, the part severed from the bar and the stock fed forward to a stop ready for forming the shank of another piece. This operation forms the entire shank of this piece. The next operations are on the head.


Fig. 3. Using Forming Attachment

Next the partly formed piece is held shank inward in a collet chuck, and spotted with a drill in the tailstock turret. Then the hole 0.120 inch diameter is drilled to a depth of 0.360 inch. After this the 0.143-inch section at the end of the hole is counterbored for a depth of 0.110 inch.

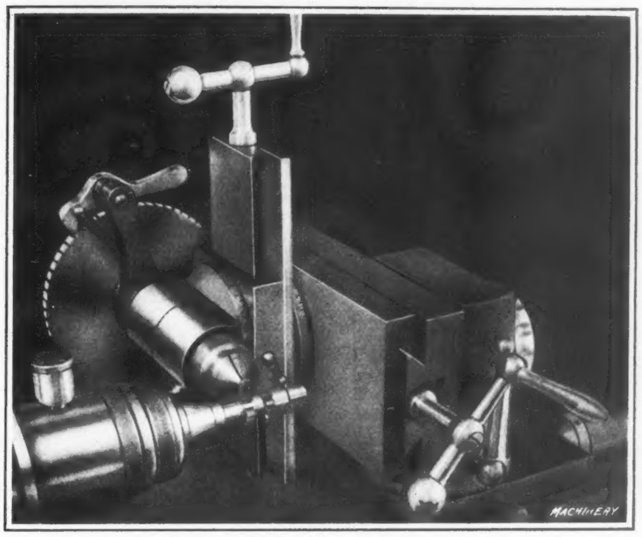
Fig. 4. Milling Attachment in Use

The third phase of the work is performed in the manner shown in Fig. 4. This illustrates the shaping of the sides and the forming of the face with the aid of the regular milling attachment for the bench lathe, the part being held by the shank in a draw-in collet. At this setting the milling of four tapered sides is done with a pair of angular mills that are held on an arbor in the spindle of the lathe. These two cutters are spaced exactly the right distance apart, and by feeding the work vertically between the cutters, two sides are straddle-milled. The part is then indexed 90 degrees, and the two opposite sides are similarly finished. The end face of this part is also concaved and grooved at this setting. The only change in the tools for doing this operation is the substitution of a hob of the correct diameter, ¾ inch, and the cross-slide is fed toward the hob until the desired finish of the face is secured.

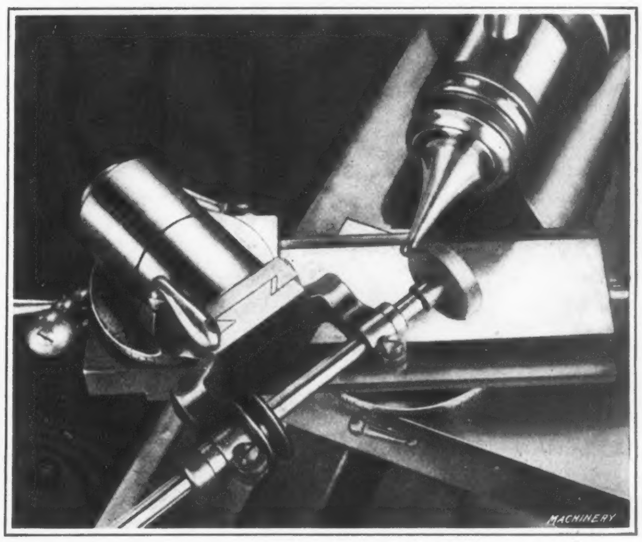
Fig. 5. Grinding Ball on Bench Lathe

The last series of operations on this part is performed upon the rear end by milling with straddle-mills so as to leave the central "fin" only, as shown in Fig. 2. After this, the part is slipped into a simple jig and a No. 60 hole is drilled crosswise through the web. This completes the part, leaving it as shown.

In the manufacture of the half-ball-shaped piece shown at *B*, the first operation is to drill and countersink the end of the bar, and then to form it with the attachment that has

been shown in Fig. 3. The part is then hardened and is ground in the manner shown in Fig. 5, using the regular Rivett grinding attachment for the bench lathe. The work is held on a stud arbor, with expanding jaws that are opened under pressure of a small screw that operates in the end of the arbor.

These two examples of work serve well to show what can be done with standard bench lathe equipment plus a little ingenuity. C. L. L.

* * *

## HOLDING WORK ON THE MAGNETIC CHUCK FOR MILLING

The magnetic chuck has for years been a familiar shop fixture for holding work for surface and cylindrical grinding, but its operation has been largely restricted to use on grinding machines because of the low gripping power usually developed. The Heald magnetic chuck made by the Heald Machine Co., Worcester, Mass., has gripping power sufficient to hold work for other machining operations such as shaping and milling. Figs. 1 and 2 illustrate vertical and horizontal milling operations, as performed on work held

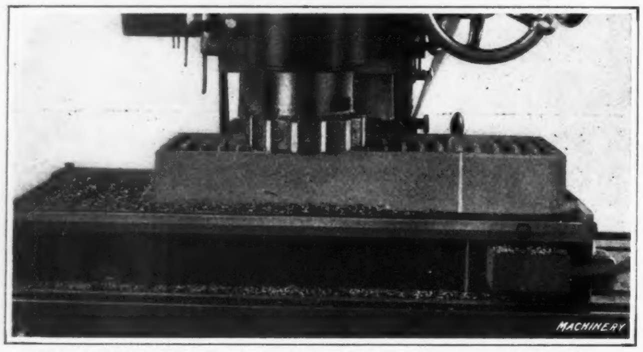


Fig. 1. Magnetic Chuck used for holding Work for End-milling

with Heald chucks. Fig. 1 shows an end milling operation on the body of a magnetic chuck casting; the material in this chuck casting is cast iron, and the depth of the cut is 3/16 inch. These castings are 8 inches wide and 24 inches long, and the time required to mill one of them is five minutes. A steel plate is bolted to the end of the chuck to act as a stop against which the thrust of the cut is taken. No gripping device of any kind other than the magnetic chuck is employed for holding the work.

An even more severe milling operation is the one illustrated in Fig. 2 that shows the milling of a bar of cold-rolled steel, 32 inches long, 2 inches wide, and ¾ inch thick. The operation being performed is the tapering of the piece to the shape of a wedge, measuring ⅛ inch at the thin end and ⅝ inch at the thick end. The depth of the cut is 3/16 inch and the feed is five inches per minute. A feed of seven inches per minute was attempted, but the machine

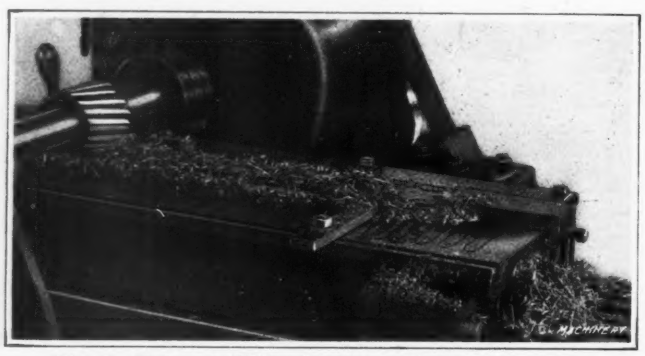


Fig. 2. Horizontal Milling Operation performed with Aid of Magnetic Chuck

would not pull the cut. No holding-down clamps of any kind are employed, but guide blocks at the sides and one end are used to support the work; these do not exert any downward pressure on the work. The chucks furnish the holding-down power, and show absolutely no tendency to allow the work to lift or move. C. L. L.

## FLASHBACK IN THE WELDING TORCH

### ITS RESULTS, CAUSES AND METHODS OF PREVENTION

BY M. KEITH DUNHAM*

Flashback in the welding torch is the skeleton in the closet of the oxy-acetylene industry. We who have sold apparatus, especially in the early days, know the care we have taken in demonstrating the equipment not to bring the welding tip too close to the molten metal, how we avoided unduly heating the head, and with what inward fear and trepidation but outward nonchalance, we turned over the torch to the green workman and awaited the almost inevitable scream of the flashback, as the trembling hand plunged the tip into the molten mass of metal. You who use apparatus or are around where it is being used know the unpleasant noise when the torch flashes. If you are a nervous man you are invariably startled, yet there is no danger; but the user must figure the results of flashback on a dollars and cents basis, for persistent flashback will waste gases and labor to an enormous extent.

Catalogues are very reticent when it comes to the question of flashback. Instruction books say that it is caused by lack of acetylene pressure, by the sparks igniting the mixture (this explanation seems wholly mysterious, as the mixture is already ignited), by forcing the flame back into the mixing chamber when it is brought too close to the metal, by excess heating of the chamber or nozzle containing the mixed gases, by a burr or obstruction in the tip, etc. The manufacture of oxy-acetylene apparatus apparently being a profitable one, and the industry still being in its swaddling clothes, it presents an inviting field for the brass specialty factories to enter. In many cases their product has shown real Yankee ingenuity, but unfortunately with unmistakable evidence of a lack of knowledge of the requirements of the gases used. One of these tell-tale features is the persistent flashback of the torch when any tips but the smallest are used or when the weld is being made on a hot casting where the heat rising to the torch from the metal is considerable.

The user of such a torch generally will swear at oxy-acetylene welding rather than by it, so for the good of the industry let us open the closet and look at the skeleton. Flashback is costly; the gases burn just the same, but they burn inside the torch, and in the meantime the weld begins to grow cold. This means lost labor, lost gases and the likelihood of producing blow-holes or unfused metal, while the torch is being cooled, relighted and readjusted. I have in mind the welding of two gears, each identical in weight, shape and character of weld. The welds were preheated and kept at a red heat by gas torches during the time that the weld was being made; this is a rather difficult test for a torch, but one which is frequently necessary where heavy castings are welded. Two different welding torches were used, the work being started on both gears at the same time. I remember that the workman using the correctly designed torch finished the weld in a little less than forty minutes without a flashback. We gave up timing the other man when the hour limit was reached and he had had eleven flashbacks. Each torch had the same size of tip, the hourly consumption of oxygen being about 50 cubic feet. One can readily appreciate, then, that on heavy hot work, a torch which has the "flashback habit" may easily cost from 25 to 100 per cent more to operate than the torch which is free or relatively free from flashbacks.

The results of a flashback are a considerable source of annoyance; they introduce the possibility of poor welding and are responsible for a serious loss of efficiency. The cause is a little more difficult to understand. Acetylene will not burn unmixed with air or oxygen; but it must be remembered that the welding torch does mix the oxygen with the acetylene in the tip, the head or sometimes just beyond the handle. A mixing chamber and tip are shown in the accompanying illustration which does not represent any particular torch, but is a general type. It has already been

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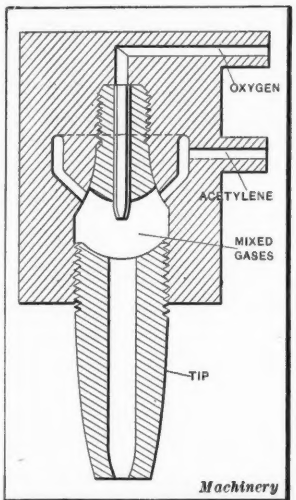
found that acetylene and oxygen will burn backward, *i. e.*, against the flow, unless the mixed gases have a speed of 330 feet per second. Note carefully that it is not one gas or the other which must attain this flow, but both together.

One of the first causes of a flashback may be lack of velocity; and in securing the necessary speed, the manufacturer unfamiliar with the proportions of gases, and using the general type of mixing chamber illustrated, is very likely to secure an oxidizing flame by using a high oxygen pressure to attain the proper velocity. This is the reason why, when all other explanations of flashback seem futile, the instruction book tells you to increase the pressures. But suppose that the pressure has been increased until the flame will stand no more and is ready to blow away from the tip; that the velocity is even in excess of that required and the torch continues to flash. We unscrew the tip and may find a shoulder caused by careless drilling, perhaps a chamber or recess (common with copper-end tips) or maybe some chips or filings. Did any one of these cause the flash? Perhaps so, since an obstruction or depression would have the tendency to retard the flow of gas temporarily, and therefore cause the speed of the gases to be momentarily checked and the flame to back up to that point.




General Type of Mixing Chamber and Tip used in Oxy-acetylene Torches

We secure a perfect tip, thread it into the chamber and begin welding again. This time the torch works much better, but when we start welding in a depression, where there is no escape for the heat waves except directly against the flame, the torch again flashes, and this time we must look for trouble elsewhere than in the tip. We note that there is soot or carbon in the chamber of the mixed gases, so we must conclude that this chamber has in some manner acted as a retarding agent and checked the proper speed of the gases. This mixing chamber or expansion point is necessary in some types of apparatus, especially where the acetylene is under little or no pressure and the force of the oxygen must be used to inject or suck the proper proportion of acetylene into the nozzle. The velocity of the gas in this case might be too great to hold the flame at the end of the tip, so the expansion chamber is necessary to retard the speed. But if these mixed gases are not everywhere moving at the required speed to prevent the backward propagation of the flame, the flame will burn back if sufficiently tempted to that point where the speed of the gases is not sufficient.

Perhaps the construction of the torch is such that it permits unscrewing the mixing chamber from the head. In such a torch we may find soot or carbon in the acetylene chamber, perhaps as far back as the entrance of the acetylene tube to the head. Then the gases must have been burning back to this point. Since acetylene alone will not burn without the air or oxygen mixture the oxygen must have "backed up" to this spot, and the speed of the gases at this point being very low (the acetylene under a comparatively low pressure and only a small amount of oxygen backing up) the flashback continued here until the gases were shut off. Here is the cure for all flashbacks—preventing the oxygen from entering the chamber or tube of acetylene will absolutely prevent flashbacks, providing the speed of the mixed gases is up to the required point.

Obstructions, depressions or rough spots in the tip will cause a momentary backfire but will not cause a flashback. The backfire is simply a snapping, *i. e.*, a tendency to burn backward; the flashback is the actual burning back of the flame which continues till one or both of the gases are shut off. A torch may show this tendency to burn back, but will not do so if the rule outlined above can be followed in construction details. Curiously enough, it may be impossible to so construct the torch as to prevent the mixture of the oxygen with the acetylene at the wrong point; it depends entirely upon the pressure of the acetylene. If the low-pressure type of generator is used, delivering the gas to the torch under a few ounces pressure, the high velocity of the oxygen necessary to inject the acetylene must result in a considerable opportunity for this high pressure to back up or partially back up, and mix with the acetylene to cause a flashback. This high velocity also makes necessary an expansion chamber as previously noted, which is another temptation to retard the speed of gases too much. Nevertheless, in torches of this type, it is possible by very careful construction and with a full knowledge of the difficulties, to get good working results; but the torch cannot be absolutely free from flashbacks since it is mechanically impossible to prevent the oxygen getting into the acetylene chamber.

There is, however, another type of generator known as the medium pressure type, which delivers the gas to the welding torch at a pressure somewhere under 15 pounds per square inch—the limit allowed at the generator. With the acetylene under some pressure, it is entirely possible to so reduce the velocity of the oxygen that its tendency to back up into the acetylene chamber is considerably reduced, although it is not eliminated, since the pressure of the oxygen is still considerably in excess of that of the acetylene. An expansion chamber is sometimes employed in this type of torch, but it is not necessary and if it is not used another invitation to flashbacks is obviated, so that generally speaking it is possible to construct a torch using acetylene under some pressure but the oxygen under a considerably higher pressure, so that flashbacks are intermittent only.

Besides the low- and medium-pressure types of generators, acetylene may also be used from storage tanks in which it is dissolved in acetone, and the acetylene in this instance may be delivered to the welding torch under a sufficient pressure to so lower the velocity of the oxygen that the entrance of the oxygen into the acetylene chamber becomes impossible, because the pressure of the acetylene is as great as or greater than that of the oxygen. If from this point to the burning point of the two gases the speed of both gases is correct, flashback becomes impossible under any conditions. Naturally, there are other things to take into consideration in the construction of a welding torch, such as rigidity of the flame, the proper proportion of the gases, and the possible danger of too high an acetylene pressure; and the prevention of flashback may at times be considered secondary in importance to one or all of these items.

The point to be clearly understood, however, is the desirability of using the welding torch designed for the acetylene supply. An injector torch should not be used on dissolved acetylene, for the simple reason that it does not take advantage of the pressure in the dissolved acetylene cylinder to avoid flashbacks, and while it is exactly what is required for a low-pressure generator, from the standpoint of the elimination of flashbacks (as well as for another reason not a part of this subject) it is not an economical torch to use where the acetylene is already under a sufficient pressure so that a high velocity of the oxygen is unnecessary. For the same reasons the medium-pressure torch should not be used on dissolved acetylene, but to secure the greatest efficiency the torch must be constructed in all cases with a view to taking advantage of acetylene pressure. Unfortunately, some manufacturers, either through lack of knowledge or in a spirit of "anything-is-good-enough" make and sell apparatus wholly unsuitable from the standpoint of efficiency or economy. The use of such apparatus is a serious detriment to the oxy-acetylene industry. It is well to understand that a flashback should be a rare occurrence in any type of apparatus, but that in apparatus using dissolved acetylene it can be wholly eliminated.

* * *

Chinese white silver, which is simply a variety of German or nickel silver, contains about 40 per cent copper, 32 per cent nickel, 25 per cent zinc, and 3 per cent iron.

# STANDARDIZATION OF SCLEROSCOPE OBSERVATIONS*

BY J. J. RALPH†

Criticisms are often heard concerning the scleroscope as an instrument for determining the condition of metals; and the following account of an experience with this instrument may help in extending its field of usefulness. Journals somewhat similar to that shown in Fig. 1 are used in large quantities in a shop making universal joints for automobiles. They are made from a very tough steel, drop-forged, annealed, machined, casehardened and ground. The soft tough core carries the load and takes the shock, while the case serves to prevent undue wear. Seven sizes are used, the largest being about 1½ inch in diameter at the bearing points. Inspection is very rigorous and the standards are high. A change of men brought together a new heat-treating foreman and a new foreman of inspectors, which led to a difference of opinion on the question of the proper hardness for these journals. The inspector reported that the pieces were coming too soft, while the heat-treating foreman claimed that it was impossible to satisfy the demand that they be casehardened so that they could not be touched with a file. It was proved that a new fine file of the best grade would touch even the test block used for standardizing a scleroscope, which had a hardness of 103; but the tester's files were found to be of all degrees of sharpness. No trouble had been previously experienced, and so little attention had been paid to the matter.

It was decided to employ a more exact method, and finally a scleroscope was purchased for the use of the inspection department. As a standard, the minimum limit was set to the readings taken from a journal that had seen over 60,000 miles of service in a heavy car, and that still showed grinding marks over almost all of the bearing area. But the troubles became worse; and lot after lot of the journals were returned as unsatisfactorily casehardened. The entire gamut of casehardening possibilities was tried, but without success; and the handling of the scleroscope was criticised and investigated, but no fault could be found. Finally it was proved to the satisfaction of all that a small journal giving low readings, as compared with a large journal giving much higher readings, was really harder as shown when tested with a new fine file in the hands of the same man. For the same size journal the scleroscope gave readings which could be compared, and the instrument was standardized on this basis.

The six larger journals were made from an open-hearth basic stock with a carbon content of 0.12 to 0.20 per cent, which is designated as stock A. For machine shop reasons, the smallest journal was made from stock B, which contains 0.08 per cent carbon, with a narrow allowable variation range. From a medium sized forging, four pieces were made as shown in Fig. 1; and the journals proper on these were made of different sizes to allow of comparison. Four pieces, as shown in Fig. 2, were machined directly from a bar of stock B; and flats were milled on each to find the effect of curvature and to afford a basis of comparison between the different sizes, with the unknown eliminated. Handling was made as close to regular practice as possible, and the machining and grinding limits were standard, the diameters being the same as in general use. After machining, the journals were casehardened with a regular run of work. The time was about eight hours, and the temperature was kept below 1650 degrees F. They were quenched in water direct from the hardening heat.

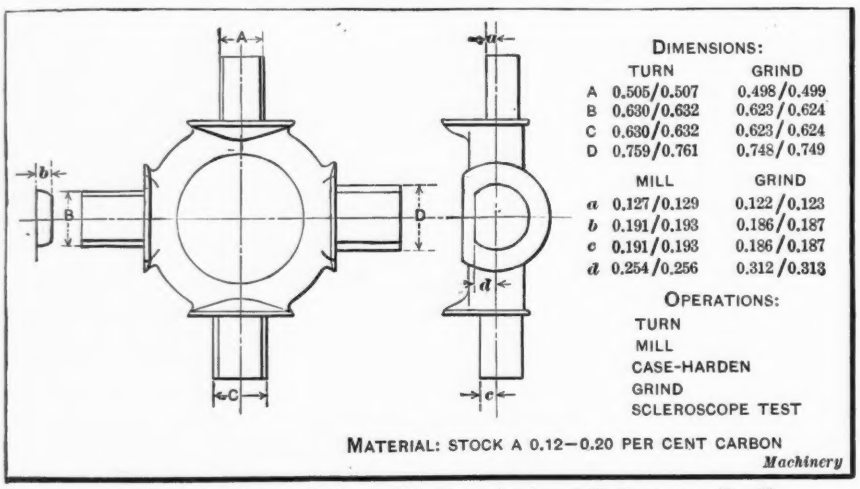



**Fig. 1. Part of Universal Joint on which Determination of Hardness gave Trouble**

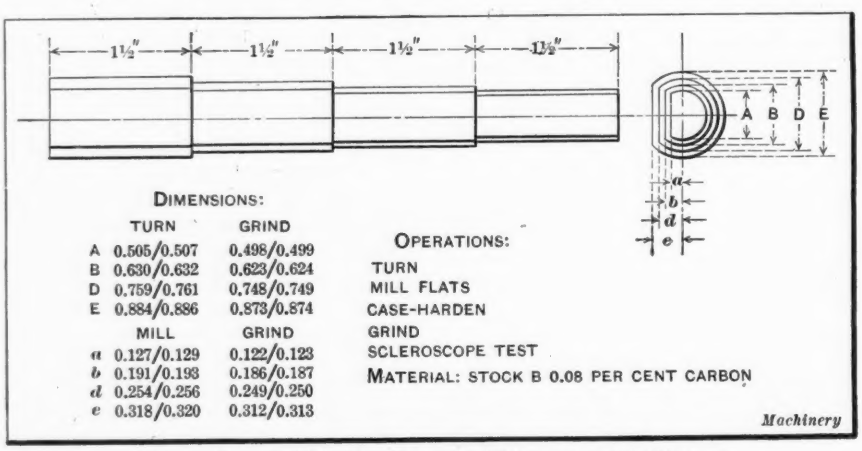



**Fig. 2. Pieces milled from Bar, with Flats to ascertain Effect of Curvature on Results of Hardness Test**

### The Test

In conducting the tests, care was taken to see that the scleroscope tube was vertical; and in taking readings on the round, the piece was centered by means of the small notch at the bottom of the guide. The flats were lined up by means of the milled surface on the bottom of the hammer guide. Two sets of readings were taken on the pieces shown in Fig. 2, one with the piece laid loose in the supporting V-block, and another with the piece held firmly. A number of readings were taken on each diameter; the maximum and minimum are given in Table I for the journals and in Table II for the test pieces. Two of the diameters of the journals were made the same to find the effect on the uniformity of the case due to difference in position. In hardening, two pieces of each kind were put in one pot and one of each kind in two other pots. The pots were then put in different parts of the furnace. Sections made at several points showed a practically uniform depth of casehardening on all, but on the small diameters and at the corners there was a slightly greater depth. The file could detect no differences in hardness. The assumption was therefore made that the case was equally hard throughout.

The following conclusions were drawn from the results of the tests: On pieces up to ⅞ inch in diameter, the scleroscope reading for the same hardness is less for small diameters than for large. For any one cross-section, the reading is higher on a flat than on a cylindrical surface. With a casehardened piece there may be as much as 30 points difference in the scleroscope reading, depending on the volume of the piece at the point tested and the shape of the surface. Both cylindrical and flat surfaces were finely ground so that the differences in readings were not to be laid to that factor. Seemingly, stock B gave about five points better results than stock A. Whether this was

* For additional information on the use of the scleroscope see also "Influence of the Scleroscope in Metallurgy and Manufacturing," by A. F. Shore, published in MACHINERY for August, 1909.

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due to greater suitability for casehardening, to its being better adapted to the casehardening treatment adopted, or to the more favorable distribution of the metal could not be told from the data of this test.

#### Shop Instructions

The following method is now employed in the manufacture and testing of the journals. A minimum limit was set for each diameter of journal. Two samples from each lot of casehardened material are roughly ground on a wheel of standard grit for that service and tested under the scleroscope. If these are found satisfactory, the entire lot goes to the grinding room; if not, they are retreated. After grinding, each journal is tested several times on each cylindrical portion to make certain that it is uniform all over, and it is then either sent to the stock room or returned. Since these precautions have been observed, the proportion of work found below standard is negligible. No trouble is ever found with soft parts in service.

#### Conclusion

The results of the scleroscope are now depended upon in that shop—when used in the proper place and in the proper manner. It is valued for what it tells about metal without injuring the finest finished surface.

* * *

TABLE I. RESULTS OF SCLEROSCOPE TESTS ON JOURNALS SHOWN IN FIG. 1

| Piece No. | ½ inch diam. (A) | | ⅝ inch diam. (B) | | ⅝ inch diam. (C) | | ¾ inch diam. (D) | |
|---|---|---|---|---|---|---|---|---|
| | Round | Flat | Round | Flat | Round | Flat | Round | Flat |
| 1 | 55—57 | 64 | 72—78 | 78 | 68—71 | 75 | 78—82 | 82 |
| 2 | 53—56 | 61 | 67—69 | 75 | 70 | 81 | 82—85 | 87 |
| 3 | 59—62 | 59- | 71—74 | 72 | 71—72 | 75 | 86—88 | 88 |
| 4 | 61—62 | 70 | 70—72 | 72 | 72—79 | 78 | 78—83 | 79 |
| Average | 58 | 63 | 72 | 74 | 72 | 77 | 83 | 84 |

*Machinery*

## JAPAN'S MACHINERY TRADE

The importations of machinery to Japan during 1914 had a value of about $12,500,000 as compared with $18,750,000 in 1913. Fifty per cent of this machinery came from the United Kingdom during both the years mentioned. Very few orders have been placed since the war broke out, but confidence is gradually returning, and it is believed that within the next few months the buying of machinery for Japan will be resumed. The Japanese government, however, is ardently supporting a policy to favor the home industries and encourages the placing of orders in Japan whenever it is possible to do so. Another important factor is that Japanese engineering works are increasing in number and capacity. It has been pointed out that makers of machinery of a class that is not too large and that is made in standard sizes should keep a small stock in Japan, so that the buyer could obtain immediately what he requires, in which case he would be more likely to buy from the importer than from a Japanese builder; but if he has to wait eight or nine months for delivery he is tempted to try the Japanese machine which he can obtain quicker and cheaper. As the importing firms are unwilling to tie up their capital in stock, manufacturers whose products can be regularly sold in Japan must be willing to place their machines in the warehouses of the local importers.

One of the interesting features of the machine shop business in Japan, according to a trade report by the British commercial attaché at Yokohama, is the very large number of small establishments consisting of a shop with one lathe and two or three employes. These small shops make a great deal of government work at low prices, as they have very small overhead charges. They do not quote on work directly, as they are too small to do that, but a sort of broker takes the order from the arsenal or other departments and then sub-lets it to these different shops. As they are conducted on such a small scale, there is considerable irregularity in the output and the rejection is large, but the competition from these small works is very keenly felt by the larger concerns. A peculiar condition existing in Japanese machine shops and other industrial plants is that the foremen are invariably in sympathy with the men and opposed to the management in case there is any labor trouble. Men of the "middle class" never gain practical experience by putting in a certain number of years in the works. Apparently they are above manual work; hence the engineers are nearly all graduates of technical colleges with little practical experience. The workmen on the whole are industrious, but their rice diet appears to be unsuitable for machine shop work, as they lack the necessary bodily weight for heavy work, and the percentage of days that they are absent on account of sickness is very high. The wages of the machinists are generally very low.

* * *

Attention is called in the *Travelers Standard* to the relation of noise to accidents. As is well known, fatigue has a notable influence in causing accidents, and anything that will tend to reduce or increase fatigue among workers is therefore, an important factor. Noise, therefore, has a prominent place in the items causing accidents, because loud noises, even if produced for only a short time, irritate the average person, and if they are continued every day and all day they will have a serious effect on the nervous system and become a serious factor in causing fatigue. Older employes in a noisy shop become more or less accustomed to noise and can generally detect any new or unusual sound that may indicate that something is out of order or that some danger is present. New men are likely to be confused by the constant loud noise and are less likely to note warning sounds. A systematic effort to suppress noise wherever possible in shops and factories will work to the advantage of all concerned. It will increase the safety of the workmen, and it is quite likely to increase their efficiency and working capacity.

* * *

The Ljusne-Woxna Co. of Ljusne, Sweden, has a power plant where power on a large scale is probably produced more cheaply than anywhere else in the world. This power plant is designed for a maximum output of 4200 horsepower, although the first installment provides for only 2200 horsepower. The fuel consists of a mixture of from 80 to 90 per cent sawdust, and from 10 to 20 per cent wood shavings. This mixture is charged into gas producers. The consumption of fuel is about four pounds per horsepower-hour, the fuel costing about 24 cents per ton at the mill. It is estimated that the cost of production with a plant of 2200 horsepower, including overhead charges and depreciation at the rate of 10 per cent per annum, will be about 0.11 cent per kilowatt-hour.

TABLE II. RESULTS OF SCLEROSCOPE TESTS ON SAMPLES SHOWN IN FIG. 2

| Piece No. | ½ inch diameter (A) | | | | ⅝ inch diameter (B—C) | | | | ¾ inch diameter (D) | | | | ⅞ inch diameter (E) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Round | | Flat | | Round | | Flat | | Round | | Flat | | Round | | Flat | |
| | Loose | Firm | Loose | Firm | Loose | Firm | Loose | Firm | Loose | Firm | Loose | Firm | Loose | Firm | Loose | Firm |
| 1 | 58—70 | 65 | 71 | 72 | 78—79 | 82 | 83 | 85 | 85—89 | 91 | 92 | 92 | 92—93 | 88 | 92 | 92 |
| 2 | 65—66 | 66 | 69 | 73 | 75—77 | 76 | 83 | 86 | 84—86 | 82—84 | 93 | 91 | 88—91 | 92 | 93 | 94 |
| 3 | 67—69 | 76 | 71 | 72 | 78—79 | 83 | 84 | 86 | 89—91 | 87 | 91 | 91 | 91—92 | 90 | 92 | 95 |
| 4 | 65—66 | 69 | 71 | 75 | 72—77 | 81 | 83 | 86 | 88—89 | 89 | 92 | 90 | 92—94 | 92 | 93 | 96 |
| Average | 66 | 69 | 70 | 73 | 77 | 80 | 83 | 86 | 88 | 87 | 92 | 91 | 92 | 91 | 92 | 94 |

*Machinery*

# TAP AND SCREW LIMITS

### THE IMPORTANCE OF OBTAINING MORE INTELLIGENT SPECIFICATIONS FOR TAPS AND THREADING DIES

WHEN one stops to consider the accuracy demanded in taps and threading dies at the present time, and analyzes the problem from all standpoints, it is interesting to note how little the close limits generally specified by buyers and users of these tools, really amount to in general practice. In fact, it is hard to see how so many intelligent buyers and users of taps and dies are led to specify ridiculously close limits, thereby causing their firms a lot of unnecessary expense and making a lot of unnecessary trouble for the tap and die makers. The only explanation of this useless refinement in specifications for taps and dies seems to be that the purchasers obtain their ideas in regard to the requirements of these tools from theorists who have little practical knowledge of the subject. If purchasers and users of taps and dies would stop to consider the cutting action of these tools, the holders in which they are used, the method of driving them, the machines in which they are used, and the condition of the tools themselves, there would undoubtedly be an immediate change in the method of drawing up specifications.

It would be quite natural for makers to believe that these close limits were specified because very accurate fits were required between the screws and tapped holes in certain lines of manufacture, such as machinery that is subjected to shocks or excessive vibration. But even in such cases, why should the taps be required to take care of all inaccuracies, *i. e.*, not only the inaccuracies in the taps themselves, but in the screws which are to be fitted into the tapped holes? Taps are always subject to inaccuracies caused by distortion during the hardening process, and it is practically impossible to eliminate errors resulting from this source, unless the taps are ground after hardening, which would add so much to their cost that few users could afford to pay for this additional work. But the dimensions of a threading die can be easily controlled; and this statement applies with equal force to both the diameter and the lead of the thread. In cases where absolutely accurate fits are required, the screws can be made by special machinery or they can even be threaded in lathes so as to obtain accurate dimensions for the diameter and lead, so that the only errors to be contended with would be those of the tap.

Another reason why a screw should be subjected to closer limits than a tap is that, as anyone at all familiar with the subject knows, a tap hardly ever duplicates its own size in the tapped hole, the hole nearly always being larger than the diameter of the tap. This result is saving many users and buyers of "close limit" taps a lot of trouble, as their specifications are generally given without any thought as to the relation between the error in the diameter and lead of the tap or screw, which serves as a further illustration of the utter lack of study and analysis of the subject which precedes the drawing up of many specifications. And if it were not for the fact that the diameter of the threaded hole is usually larger than the tap which cut the thread in it, many screws would not enter the full distance into the holes in the work. The intention in this article is to outline the conditions regarding taps and dies, their production, use and relation to each other as they actually exist in practice, with the view of familiarizing the users and buyers of the tools with these conditions in order that they may be in a better position to help solve the problem of drawing up specifications, which, at the present time, is apparently in a state bordering upon chaos.

The conditions to be considered may be briefly outlined as follows: First: The relation existing between the error in diameter and lead of the tap and of the screw; and the same relation between the screw and the tapped hole. Second: The length of the hole or nut to be tapped. Third: The relation of the accuracy of one portion of the tap to another. Fourth: The condition of the threaded portion of the tap itself. Fifth: The method of holding the tap while tapping. Sixth: The method of starting and feeding or "following up" the tap. Seventh: The relief of the threads on the tap. Eighth: The material being tapped. In order to be able to more clearly illustrate the first point given, we will take as an example a specification for a 1-inch United States standard tap, the diameter of which is not to exceed the standard size by more than 0.003 inch, while the error in the lead must not be over 0.002 inch in one inch of length. Such a specification is not at all out of the ordinary; in fact, it very closely approaches the commercial limits on this size of tap. We will also assume that the length of the nut is equal to the diameter of the tap, this being the case with both United States standard

## OVERSIZE OF ANGLE DIAMETERS REQUIRED ON TAPS WITH LEAD ERRORS AS SHOWN, TO ENABLE SCREWS TO GO THROUGH TAPPED HOLES

A. Amount of oversize of angle diameters of taps, which is required to enable a screw of standard angle diameter and standard lead to go through a tapped hole, where the lead error is as given below in a length equal to the diameter of the tap.

| Pitch or Angle Diameter | Threads per Inch | Oversize Necessary: 0.002-inch Lead Error per Inch | Oversize Necessary: 0.003-inch Lead Error per Inch | Pitch or Angle Diameter | Threads per Inch | Oversize Necessary: 0.002-inch Lead Error per Inch | Oversize Necessary: 0.003-inch Lead Error per Inch |
|---|---|---|---|---|---|---|---|
| 1/16 | 64 | 0.0002 | 0.0003 | 1 3/8 | 6 | 0.0048 | 0.0071 |
| 1/8 | 40 | 0.0004 | 0.00065 | 1 1/2 | 6 | 0.0052 | 0.0078 |
| 3/16 | 32 | 0.00065 | 0.00097 | 1 5/8 | 5 1/2 | 0.0056 | 0.0084 |
| 1/4 | 20 | 0.00087 | 0.0013 | 1 3/4 | 5 | 0.006 | 0.0091 |
| 5/16 | 18 | 0.0011 | 0.0016 | 1 7/8 | 5 | 0.0065 | 0.0097 |
| 3/8 | 16 | 0.0013 | 0.00195 | 2 | 4 1/2 | 0.0069 | 0.0104 |
| 7/16 | 14 | 0.0015 | 0.0023 | 2 1/8 | 4 1/2 | 0.0074 | 0.011 |
| 1/2 | 13 | 0.0017 | 0.0026 | 2 1/4 | 4 1/2 | 0.0078 | 0.0117 |
| 9/16 | 12 | 0.00195 | 0.0029 | 2 3/8 | 4 | 0.0082 | 0.0123 |
| 5/8 | 12 | 0.0022 | 0.00325 | 2 1/2 | 4 | 0.0087 | 0.013 |
| 11/16 | 11 | 0.0024 | 0.0036 | 2 5/8 | 4 | 0.0091 | 0.0136 |
| 3/4 | 10 | 0.0026 | 0.0039 | 2 3/4 | 4 | 0.0095 | 0.0143 |
| 13/16 | 10 | 0.0028 | 0.0042 | 2 7/8 | 3 1/2 | 0.010 | 0.0149 |
| 7/8 | 9 | 0.003 | 0.00455 | 3 | 3 1/2 | 0.0104 | 0.0156 |
| 15/16 | 9 | 0.00325 | 0.0049 | 3 1/4 | 3 1/2 | 0.0113 | 0.0169 |
| 1 | 8 | 0.00346 | 0.0052 | 3 1/2 | 3 1/4 | 0.0121 | 0.0182 |
| 1 1/8 | 7 | 0.0039 | 0.0058 | 3 3/4 | 3 | 0.013 | 0.0195 |
| 1 1/4 | 7 | 0.0043 | 0.0065 | 4 | 3 | 0.0139 | 0.0208 |

B. Conditions as given for section A of the table, except that the screw has a lead error equal to that of the tap and in the opposite direction. For example, if the tap should be 0.002 inch long in the lead for a distance of 1 inch, the lead of the screw would be 0.002 inch short in distance of 1 inch.

| Pitch or Angle Diameter | Threads per Inch | Oversize Necessary: 0.002-inch Lead Error per Inch | Oversize Necessary: 0.003-inch Lead Error per Inch | Pitch or Angle Diameter | Threads per Inch | Oversize Necessary: 0.002-inch Lead Error per Inch | Oversize Necessary: 0.003-inch Lead Error per Inch |
|---|---|---|---|---|---|---|---|
| 1/16 | 64 | 0.0004 | 0.0006 | 1 3/8 | 6 | 0.0096 | 0.0142 |
| 1/8 | 40 | 0.0008 | 0.0013 | 1 1/2 | 6 | 0.0104 | 0.0156 |
| 3/16 | 32 | 0.0013 | 0.00194 | 1 5/8 | 5 1/2 | 0.0112 | 0.0168 |
| 1/4 | 20 | 0.00174 | 0.0026 | 1 3/4 | 5 | 0.0120 | 0.0182 |
| 5/16 | 18 | 0.0022 | 0.0032 | 1 7/8 | 5 | 0.0130 | 0.0194 |
| 3/8 | 16 | 0.0026 | 0.0039 | 2 | 4 1/2 | 0.0138 | 0.0208 |
| 7/16 | 14 | 0.0030 | 0.0046 | 2 1/8 | 4 1/2 | 0.0148 | 0.0220 |
| 1/2 | 13 | 0.0034 | 0.0052 | 2 1/4 | 4 1/2 | 0.0156 | 0.0234 |
| 9/16 | 12 | 0.0039 | 0.0058 | 2 3/8 | 4 | 0.0164 | 0.0246 |
| 5/8 | 12 | 0.0044 | 0.0065 | 2 1/2 | 4 | 0.0174 | 0.0260 |
| 11/16 | 11 | 0.0048 | 0.0072 | 2 5/8 | 4 | 0.0182 | 0.0272 |
| 3/4 | 10 | 0.0052 | 0.0078 | 2 3/4 | 4 | 0.0190 | 0.0286 |
| 13/16 | 10 | 0.0056 | 0.0084 | 2 7/8 | 3 1/2 | 0.0200 | 0.0298 |
| 7/8 | 9 | 0.0060 | 0.0091 | 3 | 3 1/2 | 0.0208 | 0.0312 |
| 15/16 | 9 | 0.0065 | 0.0098 | 3 1/4 | 3 1/2 | 0.0226 | 0.0338 |
| 1 | 8 | 0.0069 | 0.0104 | 3 1/2 | 3 1/4 | 0.0242 | 0.0364 |
| 1 1/8 | 7 | 0.0078 | 0.0116 | 3 3/4 | 3 | 0.0260 | 0.0390 |
| 1 1/4 | 7 | 0.0086 | 0.0130 | 4 | 3 | 9.0278 | 0.0416 |

*Machinery*

and Whitworth standard nuts. (See MACHINERY'S Handbook, pages 765 and 766.) We will also assume that the screw is allowed to have the same amount of error in lead as the tap, *i. e.*, 0.002 inch in 1 inch of length, and that the pitch diameter is allowed to be the same amount under the standard size as the tap was allowed to be over the standard size, *i. e.*, 0.003 inch. The tap will be assumed to cut its own correct size, a condition which is not actually the case, but which seems to be the generally accepted idea.

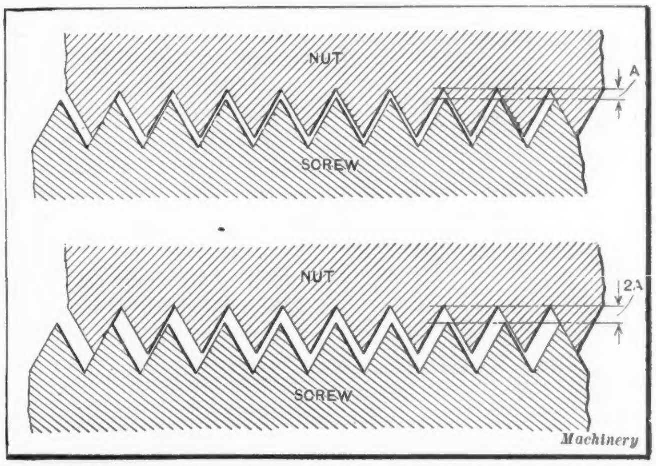



**Fig. 1. Upper Illustration shows Condition when Lead of Thread in Nut is Correct and Lead of Screw Thread is Inaccurate; Lower Illustration shows Condition when Lead of Thread in Both Nut and Screw is Inaccurate, with the Errors in Opposite Directions**

Conditions which are likely to be found in the tap are as follows: First, it is of the correct diameter with no lead error, but such a tap will not be seriously considered as its production is a practical impossibility. Second, the tap has the maximum diameter and the maximum lead error. Third, it has the correct (standard) diameter and maximum lead error. Fourth, it has the maximum diameter and no lead error. Conditions which are likely to be found in the screw are as follows: First, the screw is of the correct (standard) diameter with no lead error. Second, it is of the correct diameter and has the maximum lead error in a direction opposite to that of the tap. Third, it is of the correct diameter with the maximum lead error in the same direction as that of the tap. Fourth, it is of the minimum diameter with no lead error. Fifth, it is of the minimum diameter with the maximum lead error in the opposite direction to that of the tap. Sixth, it is of the minimum diameter with the maximum lead error in the same direction as that of the tap.

Comparing each of the conditions of the tap with those of the screw, the following results will be found: Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to allow the screw to go through the hole, the tap would have to be 0.00046 inch larger on the diameter, or the screw should be 0.00046 inch smaller on the diameter. (See table.)

Comparing the tap of correct diameter and the maximum lead error with the screw of correct diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to do so, the tap should be 0.00346 inch larger on the diameter or the screw 0.00346 inch smaller.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and no lead error, it will be found that the screw will go through the tapped hole. The screw will have 0.003 inch play all the way through.

Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to have it do so, the tap should be $0.00346 + 0.00046 = 0.00392$ inch larger on the diameter, or the screw should be the same amount smaller on the diameter.

Comparing the tap of correct diameter and maximum lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, the tap would have to be $2 \times 0.00346 = 0.00692$ inch larger on the diameter or the screw would have to be the same amount smaller on the diameter.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, the tap would have to be 0.00046 inch larger on the diameter or the screw would have to be the same amount smaller on the diameter.

Comparing the tap of maximum diameter and maximum lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. The screw will have 0.003 inch play all the way through.

Comparing the tap of correct diameter and maximum lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw has a perfect fit in the tapped hole.

Comparing the tap of maximum diameter and no lead error with the screw of correct diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will not go through the hole. In order to do so, it would have to be 0.00046 inch smaller on the diameter or the tap would have to be the same amount larger on the diameter.

Comparing the tap of maximum diameter and lead error with the screw of minimum diameter and no lead error, it will be found that the screw will go through the tapped hole. The screw will have $2 \times 0.003 - 0.00346 = 0.00254$ inch play in one end and $2 \times 0.003 = 0.006$ inch play in the other end of the tapped hole.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and no lead error, it will be found that the screw will not go through the tapped hole. In order to do so, it would have to be 0.00046 inch smaller than standard or the tap would have to be the same amount over the standard size.

Comparing the tap of maximum diameter and no lead

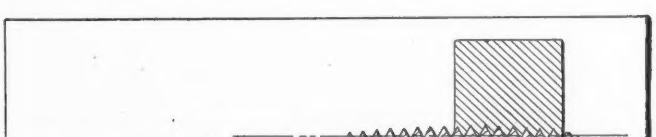



**Fig. 2. Threaded Portion of Tap is bent, which results in producing an Oversize Hole**

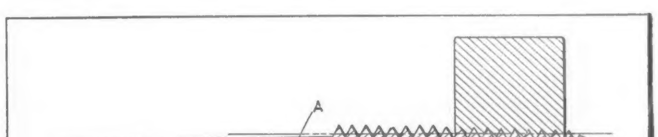



**Fig. 3. Tap bent over its Entire Length, which results in producing an Oversize Hole**

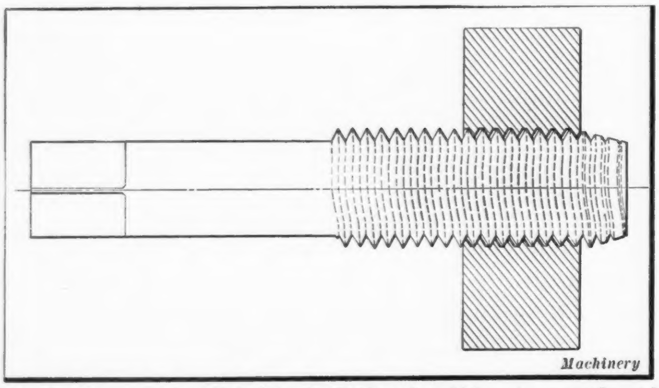



Fig. 4. Tap with So-called "Drunken" Thread, which cuts unevenly and produces Oversize and Roughly Threaded Holes

error with the screw of minimum diameter and no lead error, it will be found that the screw will go through the tapped hole. It will have 0.006 inch play all the way through the hole.

Comparing the tap of maximum diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, it would have to be $2 \times 0.00046 = 0.00092$ inch under the standard size, or the tap would have to be the same amount over the standard size.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will not go through the tapped hole. To do so, the screw would have to be $0.00046 + 0.00346 = 0.00392$ inch under standard size, or the tap would have to be the same amount over standard size.

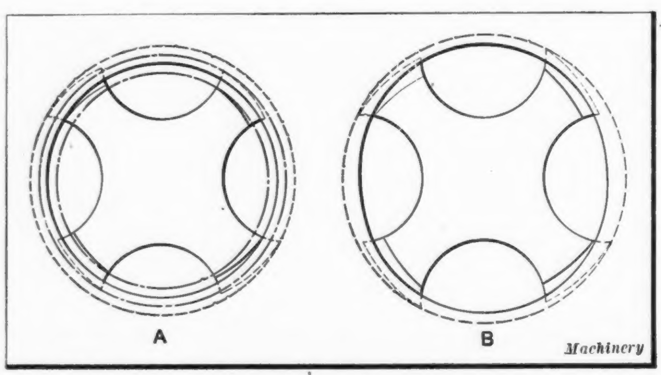



Fig. 5. A, Tap out of Round; Dot and Dash Lines show Correct Size of Hole. B, Hole in Nut out of Round

Comparing the tap of maximum diameter and no lead error with the screw of minimum diameter and maximum lead error in the opposite direction to that of the tap, it will be found that the screw will go through the tapped hole. The screw will have $0.006 - 0.00346 = 0.00254$ inch play.

Comparing the tap of maximum diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. The screw will have 0.006 inch play all the way through the hole.

Comparing the tap of correct diameter and maximum lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will not go through the tapped hole. In order to do so, it will have to be 0.00046 inch under the standard size or the tap will have to be the same amount over the standard size.

Comparing the tap of maximum diameter and no lead error with the screw of minimum diameter and maximum lead error in the same direction as that of the tap, it will be found that the screw will go through the tapped hole. It will have 0.00254 inch play.

From the preceding, it will readily be seen that were it not for the fact that taps generally cut a thread larger than their own diameter, and that screws are generally allowed larger undersize limits than taps are allowed to be oversize, there would be a majority of cases where the screw would not go through the tapped hole. Why screws in general, and more especially those used in connection with "close limit" taps, should be allowed to be a greater amount under standard size than taps are allowed to be over the standard size (and not only this, but that the screws are allowed wider limits between their maximum and minimum sizes and a greater lead error than allowed in the taps) is a condition which has not been satisfactorily explained, unless it is due to lack of study of the subject by those who are responsible for the drawing up of specifications. Before proceeding further with the subject, attention should be called to the fact that the diameter, as referred to in this article, means the pitch or "angle" diameter. The outside diameter of a tap, as long as it is up to the standard size or any amount over standard, has no particular bearing upon the fit between the screw and the tapped hole; of course, in order to have no bearing upon the fit of the screw in the tapped hole, the outside diameter of the screw must not be over the standard size.

The accompanying table has been figured out to give the minimum oversize of 0.002 inch for the "angle" or pitch diameter of taps, with 0.003 inch error per inch in the lead, to allow screws of standard diameter to go through the holes in nuts tapped with them. The nuts are assumed to be of the same length as the diameter of their respective taps; and the holes in the nuts are supposed to be the exact size of the taps in all cases. As it is reasonable to expect that the screws will have at least the same amount of error in lead as the taps (in most cases this error is very much greater than in the taps), figures have also been tabulated for screws having the same lead error as the taps, these figures being given for screws with lead errors in the opposite direction to that of the error in the taps, in order to show the great amount that the diameters of the taps are required to be oversize in order to allow the screws to go through the holes tapped with them. As in the preceding cases, these figures are based on the assumption that the taps cut to their true diameters. To thoroughly understand the preceding statements, the reader is referred to Fig. 1.

The accompanying illustrations show clearly that, contrary to the general opinion, taps do not cut to their true diameter, but generally cut a certain amount over this size; and a few words of explanation may not be out of place. One of the reasons for this cutting action of the tap is due to the threaded portion being bent, this condition being shown exaggerated in Fig. 2. This fault is very hard to remedy, and even to detect, and it is also very difficult to compensate for such an error no matter how the tap may be made, held or used. It can also be readily seen that the deeper or longer the hole to be tapped with such a tap, the greater will be the error in the hole being tapped. Of course, it may be claimed that the tap could be ground in cases where extreme accuracy is needed; but while this may sound feasible, and although it is actually done at times, the difficulty of doing such an operation

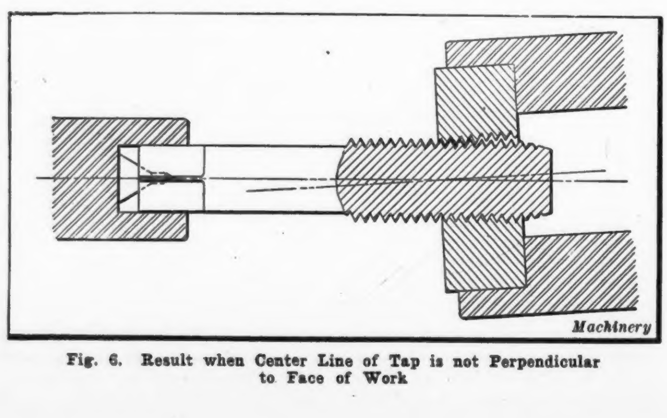



Fig. 6. Result when Center Line of Tap is not Perpendicular to Face of Work

and the added expense of such taps makes the procedure impracticable for general use. It is difficult and expensive enough to grind a plug thread gage, as anyone familiar with this work knows, and such a tool has a short thread and an uninterrupted thread surface. In a tap, the long thread and constant interruption of the thread surface by flutes, together with the provision of relief to give the required cutting action, makes the grinding very difficult.

While the preceding error in the size of a hole cut by a tap is probably the most frequently found defect due to the distortion of taps in hardening, there are other errors introduced by this operation which cause undesirable results that a close study has shown to be equally hard to remedy. A possible exception to this statement is the condition illustrated in Fig. 3, which shows a tap bent along its entire length. If this tool is not straightened, it will produce a hole tapped as shown; and even if a tap bent in this manner is straightened to run true at *A*, the defect shown in Fig. 2 will often remain, which is much harder to remedy as the portion to be straightened is short, hard all over, hard to test while straightening, etc. Two other defects resulting from the hardening operation are shown in Fig. 4 and at *A* in Fig. 5, the former illustration showing what is called a tap with a "drunken" thread, and the latter an end view of an "out of round" tap. While the illustrations clearly show the results of these errors in taps in introducing inaccuracies in the holes in which they work, it may not be amiss to mention that evenly fluted taps which are out of round will not cut uniformly, but will chatter, etc.; and this results in producing oversize and roughly threaded holes. Both of the latter defects in taps may be attributed more to the material from which the taps are made than to the method of conducting the hardening operation. Steel which has been unevenly rolled or unevenly annealed, or where the tap blank was not straight before it was turned so that the tool cut to different depths below the decarbonized surface, are conditions which are likely to cause the tap to be out of round. Aside from these sources of error, there are many minor defects of workmanship in taps, such as uneven chamfers on the different lands, excessive rake of the chamfered portion of the tap on top of the thread, an excessive amount of undercut in the flutes, an excessive amount of relief in the thread angle, etc., all of which are easily remedied, but any of which may make the taps cut holes larger than their own diameter.

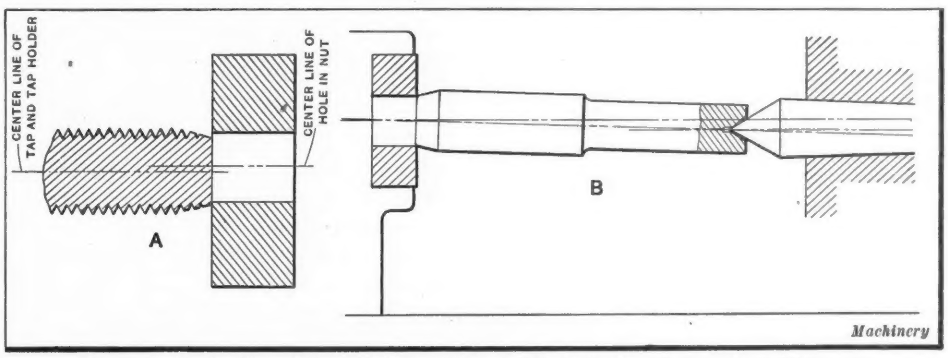



Fig. 9. A, Center Line of Tap and Center Line of Hole to be tapped are out of Alignment. B, Work-holder is out of Alignment with Center of Tap-holder

In addition to the preceding undesirable conditions in the taps themselves, there are several factors connected with the use of taps which should not be passed by unnoticed, as they may also result in the production of oversized holes.

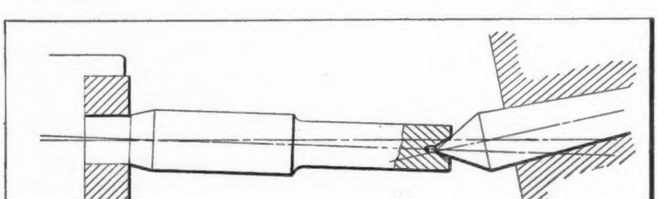



Fig. 7. Condition when Alignment of Center of Tap-holder is out of Truth, and out of Line with Center of Hole to be tapped

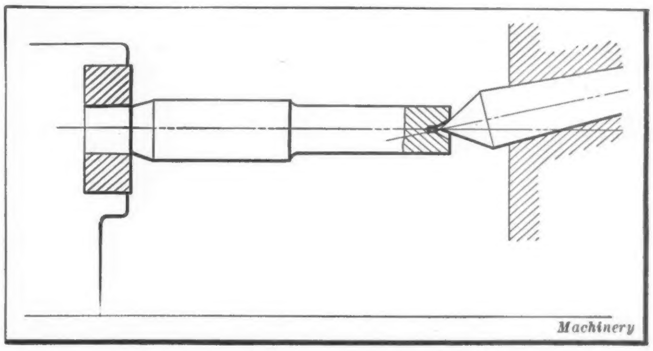



Fig. 8. Condition when Alignment of Center of Tap-holder is out of Truth, but in Line with Center of Hole to be tapped

The one most frequently found is undoubtedly that of the center of the tap-holder being out of line with the center of the hole which is to be tapped, as shown at *A* in Fig. 9. Few machine tools after they have been in use for any length of time will have the centers in accurate alignment, due to wear in the bearings and slides. These conditions are shown at *B* in Fig. 9, and in Figs. 7 and 8. Other ways in which a tap can produce an oversize, or at the best a roughly threaded hole, are shown in the following illustrations. At *B* in Fig. 5 the tapped hole is shown out of round, and at *B* in Fig. 9 the holder for the work is out of line with the center of the tap-holder, while in Fig. 6 the tap is out of true with the face of the nut. These are all common conditions and the errors which they produce can readily be appreciated. If a floating tap-holder is used, greater accuracy should be obtained, the increase of accuracy depending upon the style of floating tap-holder employed, the amount of float, the amount of error in the alignment of the centers, etc.

The condition shown in Fig. 9 would result if the shank of the tap were out of line with the threaded portion, which is a condition not infrequently found in manufactured taps. Another common condition which results in tapping oversize holes is that the tap is relieved too much in the angle of the thread or given too much of a "hooking" flute for the material which is to be tapped, and when such taps are forced to take hold of the work either by hand or mechanically they produce holes that are too large. While arguments may be put forth that taps cut oversize when working under the best conditions, and hence there is all the more reason for making them to close limits, it must be contended that the tap manufacturer or toolmaker should make a more thorough and careful study of the minor causes which make taps cut oversize, *i. e.*, such conditions as the effect of varying the fluting, relief, etc., with a view to removing those causes which are easy to overcome. This would involve no extra expense in the cost of manufacture. It must also be contended that the tap user or buyer should concentrate his efforts along the line of producing screws and bolts to close limits for those cases where great accuracy is a necessity. This is at least possible, and certainly does not require any great expenditure to be made. If those who are using taps would occasionally examine their machines, tap-holders, holes to be tapped, etc., and correct errors found in this way, they would find it unnecessary to expend large sums of money for "close limit" taps, but would be able to use those made to commercial limits. A further benefit of such a course would result from the fact that such taps are usually carried in stock by all manufacturers of taps and threading dies.

# LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

## THE ANGLE OF TORSION

The article on the "Angle of Torsion" by W. B. Gilbert, that appeared in the June number of MACHINERY, shows that he has understood my contribution on the same subject which was published in November, 1914. The illustration accompanying Mr. Gilbert's article shows one of the numerous cases where the elastic strength of shafting must be equalized, either for economical reasons or otherwise. Mr. Gilbert said that the only question in his mind was whether it would be as satisfactory to apply the motive power at a point off center. For the sake of uniformity it is desirable to have the power applied midway between the loads, or

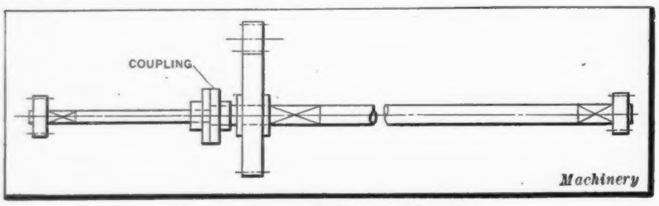



Fig. 1. Proper Position of Coupling

proportionately with reference to the angles of torsion if the loads are unequal.

I have experienced trouble of the nature Mr. Gilbert refers to, and have remedied it by equalizing the angle of torsion. A case in point was in the design of a gantry that spanned two freight tracks and a small warehouse; but in this case I had to correct the angular difference by employing a spring equalizing sprocket, as the shaft diameters could not be changed. The best and most reliable way, however, is to correct the shaft diameters by the method I have already explained. The nature of crane service is such that the angle of torsion should not exceed 0.05 degree per foot—a condition which would bring the shaft under Class I, as referred to in my article in November, 1914. Mr. Gilbert shows the shaft diameter reduction as occurring in the "distance of greatest torsion." This will cause trouble in keeping the key tight in the coupling, and even shrinking the coupling onto the shaft is not satisfactory where one end of the shaft carries the maximum load momentarily.

Fig. 1 shows the corrected position of the shaft coupling with reference to Mr. Gilbert's illustration, and Fig. 2 shows a preferable method of design. The shaft diameter at the

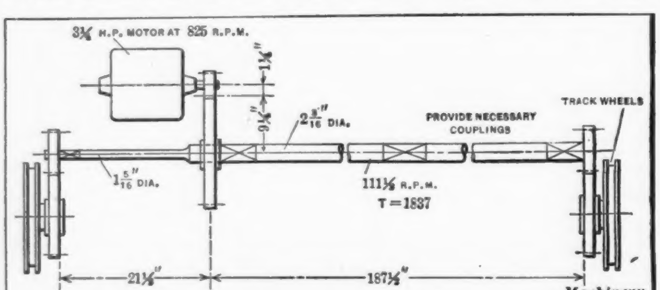



Fig. 2. Preferable Layout for Shafting of the Same Installation as Fig. 1

short end is reduced, and a shaft coupling employed to connect the shafts of equal diameters. The shaft diameters are corrected for service which comes under Class I which has already been referred to. The short length of shaft should be of high carbon steel with a carbon content of from 0.30 to 0.45 per cent, on account of the reduction in the shaft diameter; and the remainder of the shaft may be made of cold-rolled steel. In dealing with such problems in shaft design, the reader will be assisted by the table giving the modulus of torsion for various materials which appeared in connection with my article on page 198 of the November, 1914, number of MACHINERY.

Newport, Ky. B. D. PINKNEY

## HISTORY OF THE MICROMETER CALIPER AGAIN

In the article "How we came to have the Slocomb Shop Micrometer," by J. T. Slocomb, in the August number of MACHINERY, Mr. Slocomb quotes from a number of past Brown & Sharpe Mfg. Co.'s employes and expresses views regarding the early development of the micrometer caliper so contrary to the facts that for the sake of historical accuracy they should not stand uncorrected. The fact that Mr. Slocomb did not work in the micrometer department when he was employed by the Brown & Sharpe Mfg. Co., may account for his having so little knowledge of what was then being done in the micrometer line as to publish under his name statements regarding this matter that were not borne out by fact.

1. Mr. Slocomb quotes Mr. Thurston as writing, regarding the use of micrometers at the Brown & Sharpe works, that up to July, 1882, "the micrometer was very little in use, there being only two or three in the entire plant." However, the Brown & Sharpe Mfg. Co.'s stock-book, listing tools in use January 1, 1882, shows that the tool-rooms were liberally provided with micrometers, seventeen being used in the works at that date, besides those privately owned by workmen in the plant.

2. Mr. Slocomb quotes old employes as saying, regarding the use by the Brown & Sharpe Mfg. Co. of two-inch micrometers during the years 1885-90, that "as far as they knew, there was not a two-inch tool in use anywhere except the one belonging to Mr. Burnham." The stock list of January 1, 1885, shows that there were then three two-inch micrometers in use in the works and that on January 1, 1889, there were ten in use, these being in addition to those which were privately owned, such as the one referred to as belonging to Mr. Burnham.

3. Mr. Slocomb further quotes to the effect that "some time about 1880 they (Brown & Sharpe Mfg. Co.) started to make a lot of fifty one-inch micrometers." In 1880, the Brown & Sharpe Mfg. Co. was regularly making one-inch micrometers in lots of five hundred, and had been making them in lots of this size for several years prior to that date. A year or two later one-inch micrometers were made in lots of one thousand.

4. Mr. Slocomb further quotes to the effect that with the goods purchased by the Brown & Sharpe Mfg. Co. from the Victor Sewing Machine Co. "there was a precision screw made by the Pratt & Whitney Co., Hartford, Conn., and this was afterward used for making accurate micrometer screws." All that is correct about this statement is that there was such a screw at the time of the transfer of the micrometer business of the Victor Sewing Machine Co. to the Brown & Sharpe Mfg. Co. This screw and the lathe in which it was mounted were not wanted by the latter company and were sold to other parties. The Brown & Sharpe Mfg. Co. had already perfected its own machines and methods for making accurate screws and were not dependent upon the Victor Sewing Machine Co. for the accuracy of their work.

As to matters of opinion expressed by Mr. Slocomb, such as that he is the only one able to commercially cut accurate threads on tool steel and as to the value or lack of value of the clamping device for micrometers, etc., while much might be said on these points, it is not the purpose of this comment to enter into such a discussion, but simply to deal with matters of historical fact. I would, however, add in closing that in reviewing the whole situation the surprise to me is that the micrometer found its way so rapidly into use among mechanics who had been trained in the use of the vernier caliper and this especially in the Brown & Sharpe Mfg. Co.'s shop, where the latter tool had its origin.

Mr. Slocomb quotes several Brown & Sharpe workmen as remembering that half of the men owned one-inch micrometers at the time he is discussing. If this is true it would indicate a very decided appreciation of the value of this tool, being as it was in a shop so well supplied both in tool-rooms and other departments with vernier and micrometer calipers which the workmen could take for use at any time on check.

LUTHER D. BURLINGAME

Providence, R. I. Brown & Sharpe Mfg. Co.

## TWO USEFUL TYPES OF BORING-BARS

Two useful types of boring-bars that were designed to speed up operations where the adjustment or changing of tools had formerly consumed too much time, are shown in the accompanying illustrations. The bar shown in Fig. 1 is for performing recessing operations, and it can be very quickly set to bore a recess of specified depth. The feature of the second type of bar, shown in Figs. 2 and 3, is the holder in which the bar is mounted. This is particularly useful in cases where the roughing and finishing operations have to be performed with separate bars, the holder enabling the change of tools to be made in a very short space of time. The same type of holder could be used for carrying the reamer used for the following operation.

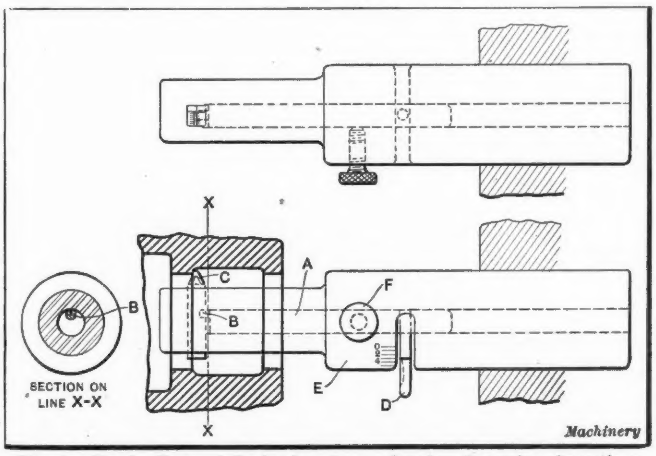



Fig. 1. Handy Type of Boring-bar for performing Recessing Operations

It will be seen that the recessing bar shown in Fig. 1 is made with a hole through the center in which a shaft $A$ is mounted. This shaft has an eccentric teat $B$ turned on one end to fit into a slot cut in the side of the recessing cutter $C$. In operation, the hole in the work is first bored out, after which the recessing is done in the following manner. The shaft $A$ is turned by means of the pin $D$ which swings in a slot cut in the body of the bar $E$, until the teat $B$ has carried the recessing cutter $C$ back a sufficient distance to enable it to enter the hole that has already been bored in the work. The bar is then advanced into the hole to be recessed and located in the correct position to start the cut, after which the shaft $A$ is again turned until the cutter $C$ has been advanced into the work to the depth to which it is required to machine the recess. This depth is easily determined by means of the line on the pin $D$ which is brought into coincidence with the proper graduation on the body of the bar. After the cutter has been located in this way, the shaft $A$ is locked by tightening the binding screw $F$, and when this has been done the recessing operation is performed. The cutter is then drawn back into the bar to enable the bar to be removed.

It frequently happens that a number of holes are to be drilled and reamed in a single piece, or that roughing and finishing operations require the use of different tools, and considerable time is occupied in making such changes. To overcome this difficulty, the spindle-nosed fixture shown in Fig. 2 was designed. This consists of any form of boring-bar with a shank which is shouldered at $A$ and which is of the proper size to fit into the socket in the driving unit $B$ in the manner shown. A driving pin $C$ is mounted in the shank of the boring-bar, this pin being of suitable size to slip into the slot $D$ in the driving unit. In back of the unit $B$ there is a steel driver $E$ which is secured to the socket $B$ by means of a screw $F$, thus enabling different units $B$ to be employed for holding different sizes of boring-bars. The driver $E$ is secured to the cast-iron member which is screwed onto the threaded end of the spindle. It will be seen that the slot to receive the pin $C$ is cut on a slight angle which tends to draw the boring-bar back and hold it in place while cutting.

The driving unit shown in Fig. 2 is suitable for a variety of boring and reaming operations but cannot be used where there is any back facing to be done. For such work the driving unit shown in Fig. 3 was designed. Referring to this illustration it will be seen that the pin in the boring-bar $A$ is held in a slot which has a right angle bend in it. In placing the bar $A$ in the driving unit $B$, the pin is slipped to the end of the straight part of the slot, after which the bar is twisted to bring the pin to the position shown in the illustration. When held in this way, it will be evident that back-facing operations can be performed without danger of the bar pulling out of the holder. This type of holder is equally suitable for ordinary boring, reaming and similar operations.

F. SERVER

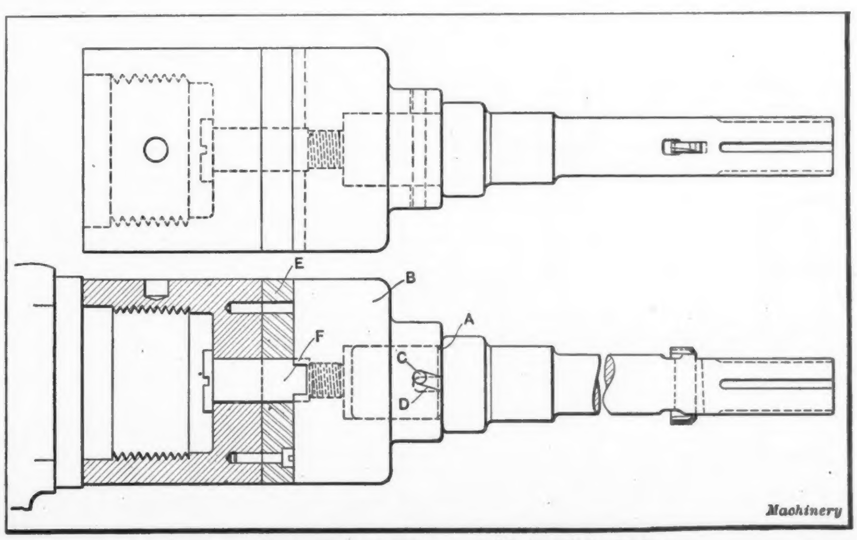



Fig. 2. Boring-bar and Holder suitable for Plain Boring

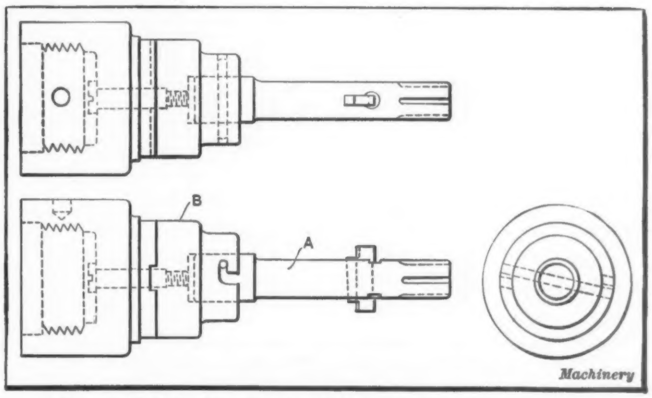
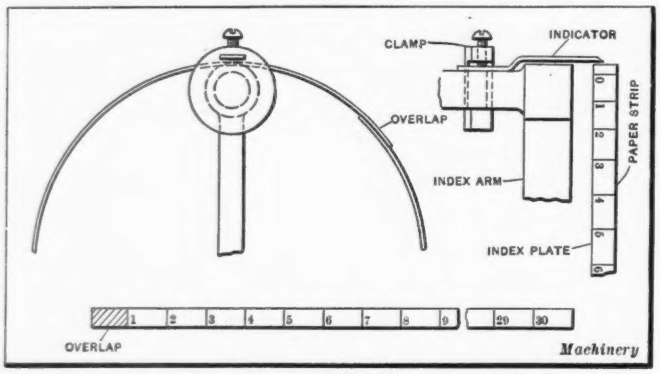



Fig. 3. Back-facing Bar with Holder similar in Purpose to the one shown in Fig. 2

## A DIVIDING HEAD KINK

Sometimes when it is required to get a certain number of divisions by means of the milling machine dividing head and the machinist starts to set up a machine for handling the job, he finds that there is not an index plate with a circle of the proper number of holes. If the work is in a hurry, or if it is not of sufficient importance to warrant ordering an index plate for the purpose, satisfactory results may be obtained by employing the simple method which it is the purpose of the following article to describe.




Method of making Temporary Index Plate with Circle of any Required Number of Holes

A fairly satisfactory index plate can be made by taking a strip of paper about 1/4 inch wide by 1/2 inch longer than the circumference of the index plate on which it is to be used. This strip of paper is divided up into the number of spaces it is required to obtain, using a sharp lead pencil for this purpose. The strip of paper is then pasted to the circumference of the index plate with the additional 1/2 inch of length overlapping. A piece of sheet metal, cut to the shape shown in the illustration, may now be clamped to the index arm so that the point extends over the divisions provided on the circumference of the plate to form an indicator.

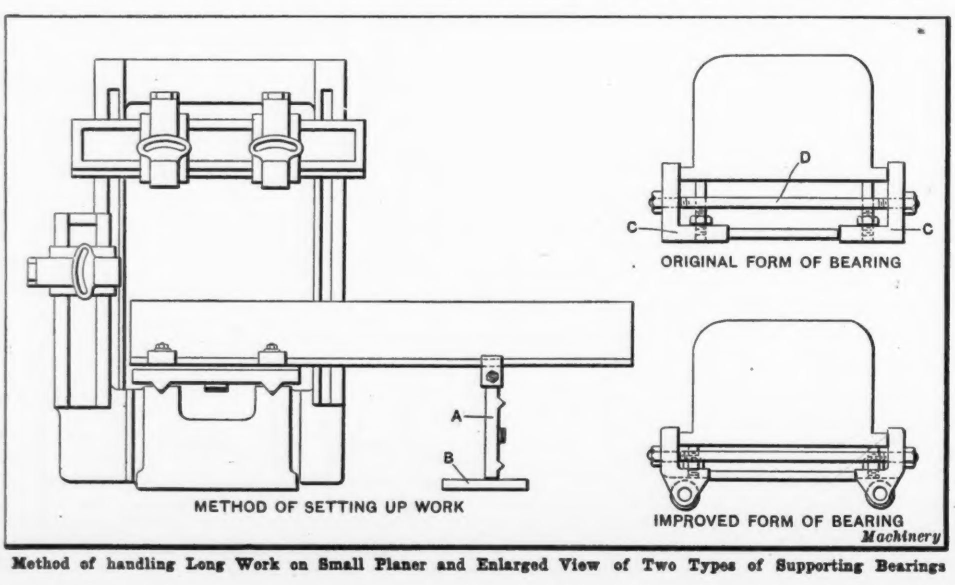
Although the results obtained by this method are not as reliable as where a regular index plate is used, they will be found reasonably satisfactory. Assuming that 40 revolutions of the index arm are required for one revolution of the work, and that the diameter of the work is the same as that of the index plate, it will be seen that it would require an error of 0.040 inch in the indexing to produce an error of 0.001 inch in the work.

Newark, N. J. GUSTAVE A. REMACLE

## HANDLING LARGE WORK ON A SMALL PLANER

The accompanying illustration shows a method that has proved very satisfactory for finishing the ends of a number of long castings on a small planer. The castings were located on the planer table in the position shown, and the cutting tool was carried by the auxiliary housing. To support the overhanging end of the work, an old planer table *A* was set up on edge, and fastened to a cast-iron baseplate *B* on the floor. The form of sliding bearing originally used for supporting the extended end of the work, is shown in detail, as well as the improved bearing now in use. Two right-angle castings *C* were clamped to the side of the work by means of the long bolt *D*, their bottom surfaces acting as the sliding bearing on the edge of the planer table *A*. The work was adjusted to the correct level by means of the studs threaded into the bearings.

This form of bearing was later changed to a roller bracket, which developed less friction. The edge of the planer table used as the bearing surface was well lubricated. It would appear at first sight that the overhanging end of the work would lag and tend to shift the position of the casting at the moment of reversal of the planer table, but no difficulty was experienced from this cause. This probably would have occurred if the casting had been supported under the extreme end. The planer used for this work measured about 3 feet 6 inches between the housings, and the castings were about 8 feet long. This method can be used only when the distance from the cutting tool to the housing face is greater than the width of the work.

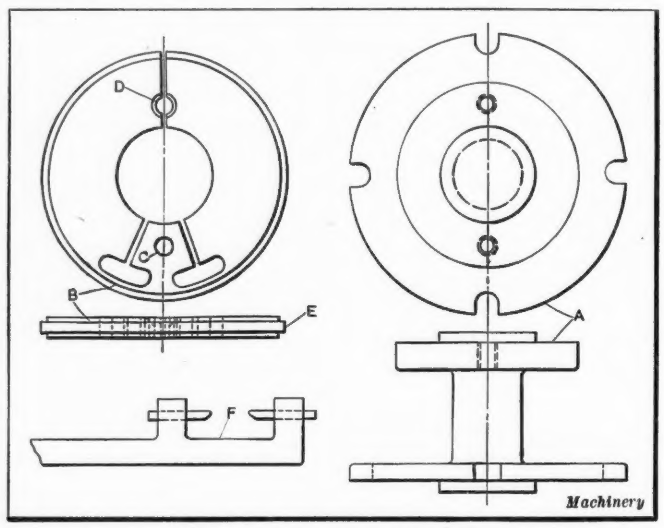



Method of handling Long Work on Small Planer and Enlarged View of Two Types of Supporting Bearings

Moore, Pa. JOHN LEAFSTROM

## FACING PISTON RINGS

In the following is described a fixture for facing piston rings. Referring to the accompanying illustration, the part *A* is made of cast iron and fitted to the nose of the lathe spindle in order to make it come central, while the four slots enable the fixture to be bolted to the faceplate. The part *B* is made of machine steel about 3/4 inch in thickness and is a running fit on the pilot of fixture *A*. Part *B* is secured to part *A* by means of one straight screw at *C* and one tapered screw at *D*, the tapered screw spreading the plate *B* and tightening it against the inside of the piston ring.




Fixture for Use in facing Piston Rings

The offset *E* on the plate *B* is provided to accommodate rings that are of less thickness than the plate. Plates *B* of various sizes to hold the different piston rings which are to be faced, can be used on the same fixture *A*. The facing is done by tools held in a tool-holder of the form shown at *F*. The tools are made of square high-speed steel and held in position by set-screws in the usual way. They are set at the correct distance apart, and one cut taken with the cross feed reduces the ring to the desired thickness and makes its sides parallel.

Franklin, Pa. A. F. MANSBERGER

## UNIVERSAL LINK-CUTTING DIE

We had to make a number of links of various lengths, all of which were 3/8 inch wide by 1/8 inch thick, with a 3/16-inch hole at each end, as shown at *A* in Fig. 1. Instead of making a separate punch and die for blanking out each length of link, we made the universal tool shown in Figs. 1 and 2. The cost was no more than that of a single-purpose tool for making any one size of link; and in making the links in this way there is very lit-

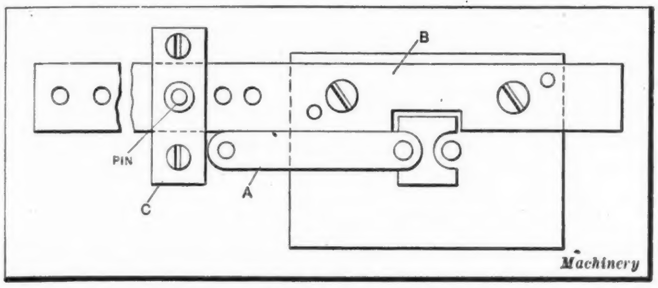



Fig. 1. Universal Link-cutting Die

tle scrap produced. The stock bought was of the correct width and thickness, and the only loss amounts to about 1/8 inch between the ends of successive links.

The die is shown in Fig. 1 with the stripper removed, in order that the design and method of operation may be more clearly illustrated. It will be seen that the stop-bar *B* is doweled to the die and extends beyond it for a distance equal to the length of the longest link that it is required to make. The stop *C* slides on the bar, in which there is a dowel-pin hole to locate the stop in the proper position for each length of link. This arrangement makes it very easy to change the die for making any size of link which comes within its range. No description of the punch will be necessary to make its design clear.

To use this punch and die, the operator first runs the stock under the punch to round off the end and punch the first hole. He then advances the finished end of the stock until it contacts with the stop *C* and again trips the press. This stroke

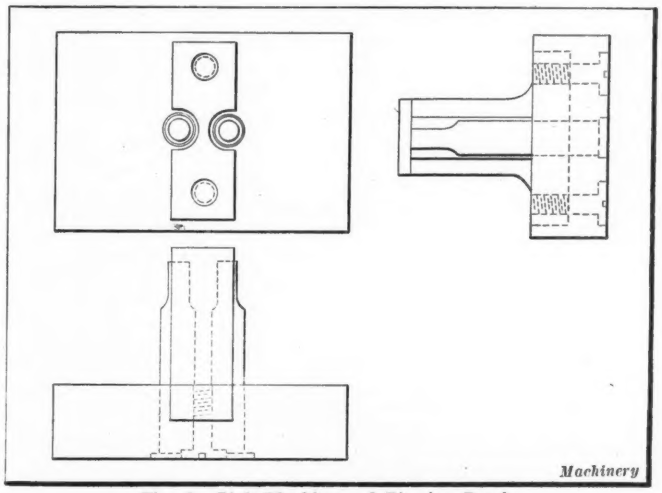



Fig. 2. Link Blanking and Piercing Punch

results in completing one link and rounding and piercing one end of the following link. It will be evident that each stroke of the press now results in the completion of one link.

Belleville, Ill. B. GEIST

## RELATIVE VALUE OF SODA AND SODA ASH

There are few substances which are used in greater quantities in American factories than soda; it is employed for cleaning machine parts, for scrubbing floors, and for numerous other purposes. Many shops have had experience in trying other cleaning compounds for which great claims are made, but eventually they come back to the use of soda. It is not the intention to say that there are not a great many good cleaning compounds on the market, but in most cases the difference between their cost and the cost of ordinary washing soda does not warrant using them.

In answer to the question "What is soda?" it may be said that it is a chemical compound known as sodium carbonate which has the formula $Na_2Co_3$, and that the greatest supply comes from Syracuse, N. Y. The actual method of manufacture is a secret process, but it is known that limestone and common salt are used in large quantities. It may be a surprise to some people to learn that nearly two-thirds of the weight of washing soda is due to the water which it contains; and that this so-called "water of crystallization" has no value as a cleaning medium. As a result, the purchaser will obtain more for his money by buying soda ash instead of soda. Soda ash has the same chemical composition but does not contain any water, and as the cost per pound is only about 10 per cent more than that of soda, it is far more economical to use. Soda ash contains certain impurities which are not found in soda, but the amount of these is less than 1 per cent and the impurities are of such a character that they are harmless.

If you wish to convince yourself of the relative strength of soda and soda ash, weigh out exactly equal amounts of the two materials and place them in beakers. Add enough water to each beaker to dissolve its contents and then run in the required amount of commercial muriatic acid to neutralize the solutions, as shown by testing with blue litmus paper or some other indicator. This test will show that the soda ash requires about 2¼ times as much acid to neutralize it as is required to neutralize the same weight of soda, *i. e.*, the soda ash is 2¼ times as strong as the soda, and one ton of it will go as far as 2¼ tons of soda.

Buffalo, N. Y. GEORGE B. MORRIS

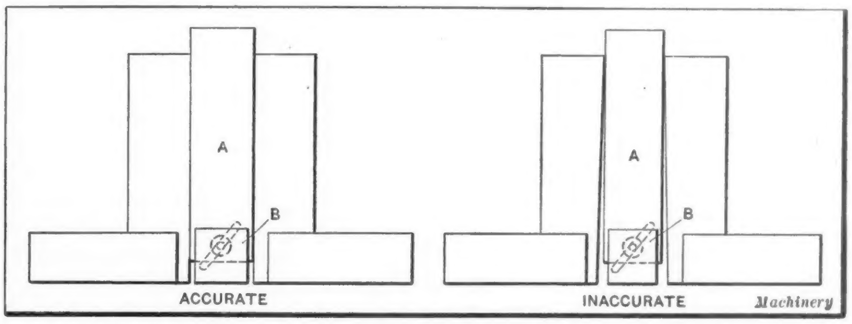



Fig. 1. Method of testing a Square with a Straightedge and Surface Plate

## TESTING A SQUARE

It is common though incorrect practice to test a square by comparing it with some other square. This method is unreliable because the discovery of an error does not necessarily mean that the inaccuracy is in the square being tested. Fig. 1 shows a simple test that gives satisfactory results. A strip of stock *A* with two parallel sides should be held in a clamp *B*, with the parallel sides protruding beyond the sides of the clamp. Laying this upon a surface plate, the parallel strip is brought square with the plate by tapping it at one side or the other. The square is accurate if no light can be seen when the blade is held against either side of the parallel strip. If the strip is square with the surface and the square is inaccurate, the error will appear to be of equal magnitude on each side of the strip.

Fig. 2 illustrates another method of testing a square. The cylindrical test block should be hardened and ground, and

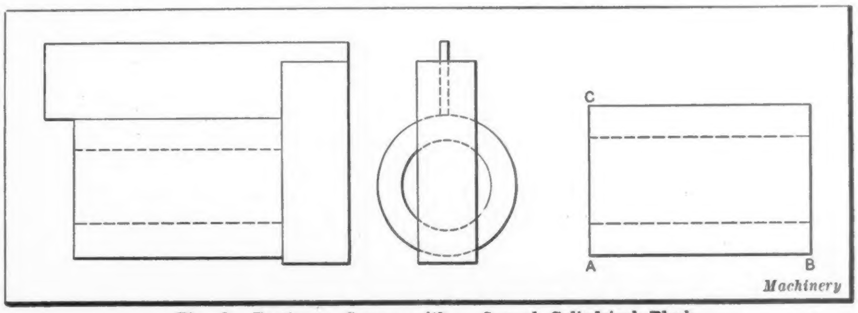



Fig. 2. Testing a Square with a Ground Cylindrical Block

when such a block has been made it can be preserved as a permanent reference gage for this purpose. In grinding, care should be taken to keep the diameter the same at all points; and the end faces of the block should be ground at the same setting. While grinding, the work should be held on a plug arbor. Assuming that the block has been ground in accordance with the preceding instructions, it will readily be seen that *AB* and *AC* form an almost perfect square, which can safely be employed for testing purposes.

Newark, N. J. GUSTAVE A. REMACLE

## MICROMETER DIALS FOR AN OLD BORING MILL

For some months I have been operating a ten-foot boring mill which is not provided with graduated dials on the feed-screws, as this is quite an old machine. Machinists who have operated this boring mill in the past have evidently felt the need of graduated dials, for the collar on each of the feed-screws bears evidence of attempts to graduate it with scribers, prick-punches or cold chisels. To set a tool with any degree of precision by such a substitute for accurately graduated dials, certainly requires a man to be a clever guesser.

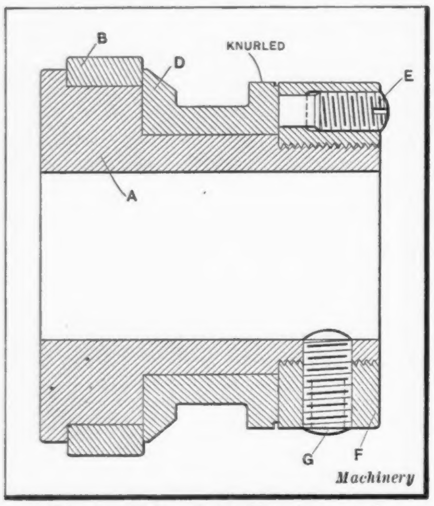



Fig. 1. Dial and its Mountings used on Feed-screws

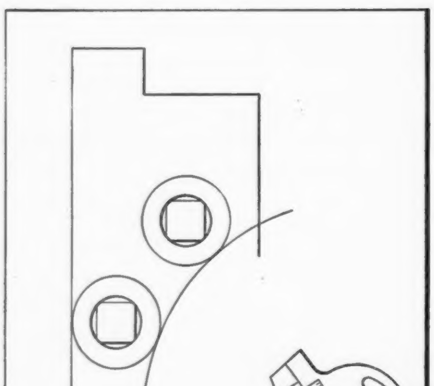



Fig. 2. Assembly View of Auxiliary Feed-screw Dial

With the view of getting something better for this purpose, the device which forms the subject of this article was developed. It consists of two principal parts, one being a dial and its mountings which may be fitted on either of the feed-screws, and the other a plate mounted on the stud which carries the gear that drives the feed-shaft pinions. Fig. 1 shows the cross-sectional view of the part used in connection with the feed-screws, and referring to this illustration it will be seen that the hub *A* carries a split collar *B* on which the pointer *C* that is shown in Fig. 2 is mounted. The dial *D* is divided into sixteen spaces, each of which corresponds to a movement of the tool of 1/32 inch. The dial may be moved around the hub for the purpose of adjusting it to the zero position, and it will be seen that it is locked in position by means of a set-screw *E* which is carried in a collar *F* threaded onto the hub. The hollow set-screw *G* holds the entire mechanism in place on either of the feed-screws on the boring mill.

Reference to Fig. 2 will show that the second part of the mechanism consists of two scales *H* and *J*, one of which indicates the traverse feed and the other the vertical feed of the tool. The traverse feed is ½ inch per revolution, and the vertical feed 7/16 inch per revolution of the feed-shaft. Both scales are divided into thirty-one divisions, and both have a range of 1/32 inch, so that each division indicates a movement of 0.001 inch of the tool.

Assuming that the device is to be used for a boring operation, it is set up on the machine as shown in Fig. 2, and the screw *K* is adjusted to locate the pointer *C* in the required position, the screw being left loose enough so that the pointer may be moved by hand. A pin placed in the hole *L* locks the pointer *C* to the scale. The tool is now adjusted to the work by means of the dial *D* and the work is brought to within 1/32 inch or less of the required size. The pin is now removed from the hole *L*, after which the work is finished to size by means of the scale *J*, which is the one used to regulate the traverse feed of the tool. Should more than 1/64 inch of final adjustment be required, it is advisable to move the pointer to the end of the scale *J* before starting the final finishing cut. This device can be easily shifted to any of the feed-screws; and it offers a means of improving the efficiency of the machine by providing an accurate method of showing the amount of traverse and vertical feed, where the usual form of dials cannot be used on the feed-screws.

Butte, Mont. W. WHITLEY

## TO PREVENT FOUNTAIN PENS LEAKING

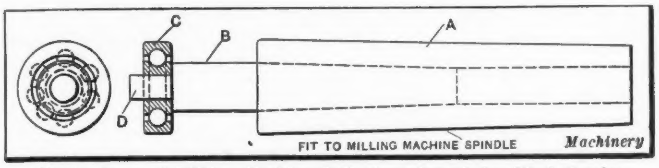
Fountain pens are likely to leak at the joint where they part for filling. While this leak is small, being simply a capillary effect, it is none the less annoying, for no matter how dry the joint is wiped, the fingers are bound to become smeared whenever the pen is used, because they touch at this very joint. To prevent this trouble, use "tanglefoot" such as found on sticky fly paper or painted on trees to keep the insects from climbing. Put a small amount on the threads and joint with the point of a toothpick, screw the joint together and wipe off the surplus. This "tanglefoot" always remains sticky, never dries up and no ink can ever pass by it. One application will last at least a year in continuous use.

Newport News, Va. OSBORN P. LOOMIS

## MILLING MACHINE INDICATOR

The accompanying illustration shows a very simple and dependable form of indicator for use on milling machines in cases where it is required to bore a hole at a certain distance from a finished surface, or for locating the table at a given distance from the center of the spindle. The tapered bushing *A* fits in the milling machine spindle and is bored with a tapered hole to receive the spindle *B* on which the ball bearing *C* is mounted. This spindle can be made any required length, or several spindles of different lengths can be made to fit in the same bushing *A*. The diameter of the projection *D* on the spindle is made of such a size that the inner race of the ball bearing can just be pressed onto it by hand, and this part of the spindle should be turned with the indicator in place in the milling machine spindle. For this purpose the turning tool is held in a vise on the table of the machine.

To use the indicator, the finished face on the work is fed against the outer race, and as soon as the work touches, the race will stop rotating. The dial of the feed-screw is then set to zero, the table backed clear of the work, and then moved longitudinally or vertically, as the case may be, through a distance equal to one-half the diameter of the outer race. This brings the center of the spindle exactly in line with the finished face on the work. The dial on the feed-screw is again set to zero, after which the work is



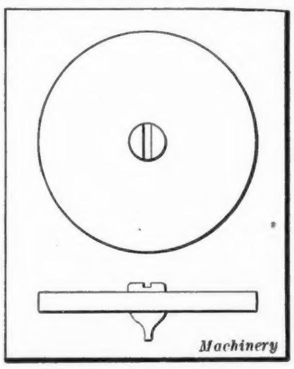

Simple Type of Milling Machine Indicator adapted for Hard Service

moved through the required distance to locate it in the proper relation to the spindle for boring the hole in the work. A steel disk may be used on this type of indicator in place of the ball bearings, but it is not nearly so sensitive.

Denver, Colo. STANLEY EDWARDS

## DIE-SETTER'S SCREW-DRIVER

The accompanying illustration shows a convenient form of screw-driver for use in setting up tools in a power press, which is especially useful when it is desired to replace the stripper without taking the cutting die out of the bolster. An ordinary screw-driver could not be used because there would not be enough room under the plunger of the press. In cutting out stock for jewelry, the stripper plate is generally removed and the stock sheared to fit the guide slot in it. In the meantime, the punch and die have been set up in the press, and when the operator receives the stock and stripper plate, the use of this tool enables him to attach the stripper very easily.




Die-setter's Screw-driver

A screw-driver of this form is much easier to handle than the common form of offset screw-driver. The forefinger of the left hand is placed at the top of the disk to apply the necessary pressure and the disk is turned with the thumb and second finger of the right hand. The edge of the disk is knurled so that a good grip may be obtained. I have also made tools of this type with the edge of the disk scalloped, and also with a star shaped handle in place of the disk, but the form of tool shown in the illustration has given the best all-around results. The disk has a square hole in the center and the screw-driver is milled so that it can first be driven into the hole, and then riveted over at the top. In hardening the screw-driver, care must be taken to leave the shank soft enough so that it can be headed over. The foreman of the press department came into the tool-room where the writer is employed, saw this tool lying on the bench, and carried it right out to the press room. After using it, he declared it the handiest screw-driver for the purpose he had ever seen.

Attleboro, Mass. T. E. WARD

## FIXTURE FOR GRINDING THREADING TOOL CUTTERS

The grinding of threading tool cutters of the form shown in Fig. 1, which are used in spring or so-called "gooseneck" holders, is often found difficult because the cutter is quite short and hard to hold while grinding. Furthermore, it is difficult to grind the angle true for the entire length of the cutting face, so that when the tool is sharpened it will only need grinding at the top. The fixture shown in Fig 2 was designed for doing this work and has given satisfactory results.

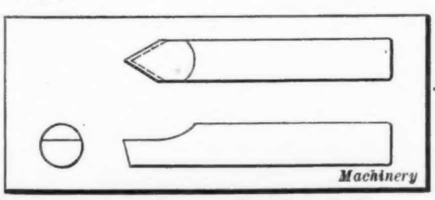



Fig. 1. Type of Threading Tool Cutter to be ground

The baseplate *A* has a ridge planed on it at an angle of 15 degrees, which will give the cutter the proper clearance. Plate *B* is secured onto the ridge on the baseplate, and a Starrett protractor *C* is screwed to the plate *B*. The tool to be ground is carried in a toolpost *D* which is held stationary by the lock-nut *E*. In setting the fixture ready for grinding any required tool, the indicator *F*, carried by the toolpost, enables the proper setting on the protractor to be made.

In using this fixture, the tool is first tightened in the toolpost; then the lock-nut is unscrewed and the indicator set to one-half the included angle which is required on the cutter. The lock-nut is then tightened to secure the tool in place preparatory to grinding. The fixture can be used by passing it under the surface grinder by hand or it may be strapped to the table of the surface grinder and the machine used in the regular way.

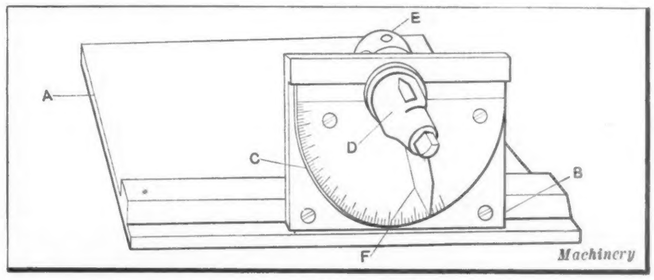



Fig. 2. Fixture for grinding Threading Tool Cutters

Waterbury, Conn. CHARLES GRILLEY

## METHOD OF HOLDING LONG DRAWINGS

In the drafting-room where the writer is employed some very long drawings are made, and as the longest available board is only 6 feet in length, the following method is used to hold the portion of the drawing that is not being worked on. A roller and guide are secured to each end of the drawing board by strips, as shown in the accompanying illustration; one end of the paper is pasted onto each roller and it is then wound up tight on one roller. As the work progresses, it will be apparent that the paper is drawn off one roller and wound up on the other one until the entire drawing has been completed.

JAMES B. NELSON
Toronto, Ontario, Canada.

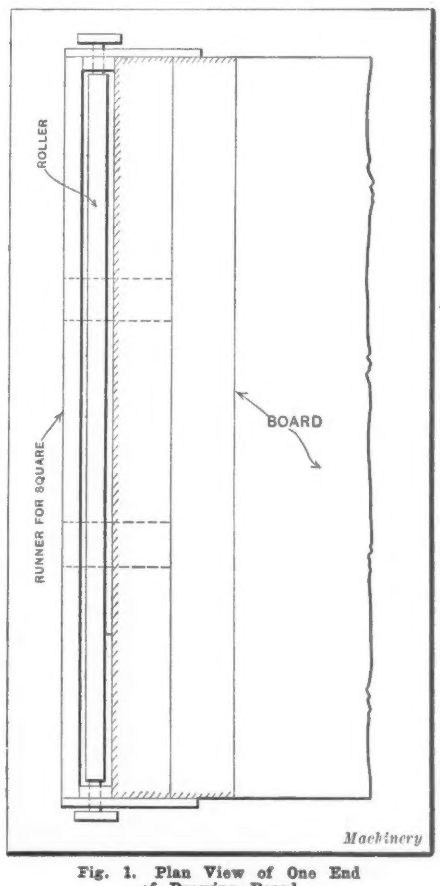



Fig. 1. Plan View of One End of Drawing Board

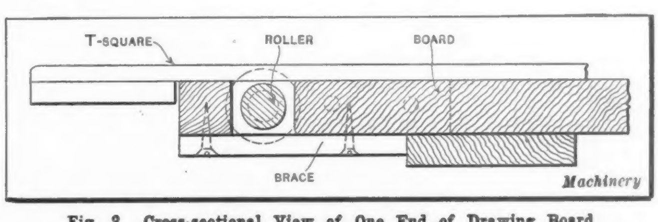



Fig. 2. Cross-sectional View of One End of Drawing Board to a Larger Scale

## TWIST DRILL DESIGN

We have read with much interest the editorial entitled "Standard Twist Drill Design" in the August number of MACHINERY. The implication seems to be that the business of manufacturing twist drills has been, until very recently, a "rule-of-thumb" affair in which a certain design has happened to become standard because each new arrival in the field has blindly accepted the traditions of his predecessors. This state of affairs is now somewhat altered, however, by the fact that "a *new* development has recently been made by a twist drill maker in changing the angle of lead of the flute".

We are inclined to think it will be interesting news to the majority of twist drill manufacturers to learn that there has heretofore existed a standard design for such tools other than the separate standards of individual makers. As to the matter of the angle of spiral, let me quote from a little booklet, "Twist Drills—Their Uses and Abuses", first published by the Cleveland Twist Drill Co. some fifteen years ago:

"There are various shapes of flute and angles of spiral on the drills made by different manufacturers, the shapes of flute varying by only a small amount, while the angles of spiral range from 18 to 35 degrees. Theoretically, the finer the pitch of the spiral grooves, or the greater the angle of spiral to the axis, the easier it should be to sever and bend or curl the chip; but there are practical considerations which counteract the advantage of mere ease in severing chips, and it becomes advisable to make this angle somewhat more acute than would otherwise be the case. Among the practical objections to a very fine pitch of spiral may be mentioned the weakness of the cutting edge and its inability to carry off the heat generated. Such a groove also packs up with chips more readily. From a large number of tests we have found that angles of spiral ranging from 25 to 30 degrees give the best results in drills for average work—*i. e.*, where the holes are between one and three diameters deep. For deeper holes than this, a coarser pitch (with less angle to the axis) might be desirable, and for shallower holes, a finer one."

The recognition of the value of various angles of spiral for various purposes is, therefore, not new, and twist drills differing considerably with respect to this angle have been on the market for a number of years. The question is asked:

"Is there any assurance based upon practical tests carried out with scientific precision, that twist drills are made of a form most advantageous for the rapid removal of metal?" In our judgment the answer to this question hinges largely on the meaning of the words "scientific precision". We do know, however, of several lengthy tests that were made on a carefully prepared apparatus by expert workmen, to determine the very points in question. (A description of this apparatus appeared in the *American Machinist*, May 30, 1901, and will also be found, together with a review of the tests, in the booklet "Twist Drills—Their Uses and Abuses.") The result was that one manufacturer expended large sums of money (1) to change the angle of spiral on the bulk of his product from within the range between 33 and 35 degrees to within that of 25 to 27½ degrees, and (2) to procure an entirely new equipment of cutters to produce a shape of flute which should, while consuming practically no more power, free itself of chips more readily. We also know that a 1½-inch twist drill has removed 113 cubic inches of metal in one minute.

We quite agree that because a thing has been made a certain way for a long time it does not follow that it is the best way, and we do not believe that one angle of spiral or of point could be found that would be best for all kinds of work. There are too many varying conditions, some of which require the sacrifice of a certain amount of power to accomplish the work at all.

We question, however, if any data sheets which attempted to cover these points would be of much practical value to efficiency engineers, unless the whole experience of a drill maker went with them. The makers of twist drills sell "holes" these days as the criterion of value for their products, and it strikes us that the shortest and most direct road to drilling efficiency is for the man that has a difficult drilling problem to put it up in detail to several of the leading twist drill manufacturers and let them furnish samples that in their judgment are best suited for the work. If these are then run under the conditions recommended by each manufacturer the user can readily select the tools that show the highest productive capacity in the job. In our judgment the twist drill manufacturers would be glad to submit their product to such competitive conditions, and would welcome any improvement in design that might be thus scientifically demonstrated to be such.

E. C. PECK,
Cleveland, Ohio. General Superintendent,
Cleveland Twist Drill Co.

## GRADUATING LATHE BEDS

In operating long lathes I have found it a convenience to have graduation marks 1 foot apart stamped in the metal between the ways, with numerals beside them which show the distance from the face of the chuck. This device will enable the operator to locate the tailstock and steadyrest when setting up the machine for long work, without having to use a rule for making measurements. These graduations will not disfigure the machine, and as they are permanent they are always ready for instant use. This has been found a great time saver in handling certain classes of work.

Los Angeles, Cal. JOHN A. WOOD

## DRAFTSMAN'S PEN-WIPER

For cleaning my ruling pens, and especially bow pens and compass pens, I find an old tooth-brush much more satisfactory than the time-honored "rag." By drawing the point of the pen across the brush, it is thoroughly cleaned without leaving any lint. This method of cleaning with a brush is much easier than squeezing a piece of cloth between the pen points. The brush lasts longer and looks better. It can be conveniently kept in an instrument tray.

Amite, La. CHARLES F. KOPP

## LUBRICANTS FOR DRILLING AND TAPPING

For drilling and tapping nickel steel, linseed oil is one of the best lubricants I have ever used. Where tool steel is being drilled with fine drills, sweet milk is a very efficient lubricant. It is important to note in this connection that sour milk will not give satisfactory results. Using a 0.020-inch drill in tool steel, I have found that the tool lasted ten times as long with sweet milk as a lubricant than it did when any other cutting compound was used.

Dayton, Ohio. O. E. VORIS

## CLEANING THREADED HOLES IN HARDENED WORK

There are many toolmakers who use a tap to remove the scale from threaded holes in a die after it has been hardened. I have found that by taking a screw and filing a few flutes in it, I can make a tool that will clean out the threads of a die just as well as a regular tap, and its use avoids damaging an expensive tool.

Long Island City, N. Y. E. KERN

* * *

### CORRECTIONS

In the March, 1915, number of MACHINERY, page 558, in the article on "Wire Springs," it is stated that $D$ = outside diameter of spring. This is an error, as $D$ = mean diameter of spring. This correction should be taken account of throughout the article.

In the article "Spacing of Bolts for Wrench Clearance," on page 982 of the August number of MACHINERY, there is an error in Formula (4). This formula should read:

$$D_1 = 1.75d + 0.062 + 0.86d + 0.072 + 0.5d = 3.11d + 0.134.$$

# NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

## GARDNER DISK GRINDER

The No. 50 disk grinder illustrated and described herewith is a recent product of the Gardner Machine Co., Beloit, Wis. The design represents a departure from standard practice in the construction of disk grinding machines, and the present machine is adapted for an unusually wide range of work. The grinder is said to have a high productive capacity and it is a complete unit, each machine being equipped with a dust exhauster, a water system, and a cast-iron hood. The spindle is made of crucible steel and accurately ground to a diameter of 3 inches; it is mounted in S. K. F. radial ball bearings, and the end-thrust is also taken by ball bearings of the same make. The spindle pulley is 12 inches in diameter by 10 inches face width, which provides an abundance of power. It will be noted that the rocker-shaft has a bearing at each end, in which it oscillates when the table is rocked back and forth to move the work over the grinding wheel. This design has resulted in a rigid construction which enables a high degree of accuracy to be obtained in the product.

When the work is forced against the grinding wheel, it will be evident that there is a tendency for the rocker-shaft to move to the right, but this is resisted by a heavy collar just outside the left-hand bearing. A second collar at the right prevents movement of the rocker-shaft in the opposite direction; and this second collar also has a ledge formed on its under side in which there is an elongated curved slot. This slot carries a stop-screw, and by adjusting the collar on the rocker-shaft and locking it with a set-screw, the limits of oscillation of the table may be accurately regulated. The table column and top are heavily constructed, the column being 5 inches in diameter. The column extends into the counterweight at a point directly over the center of the rocker-shaft, and is held in the required position by two locking-screws which pass through the left-hand side of the weight. A graduated clamp collar just above the counterweight on the column can be employed when it may be desired to set the table at an angle with the grinding wheel.

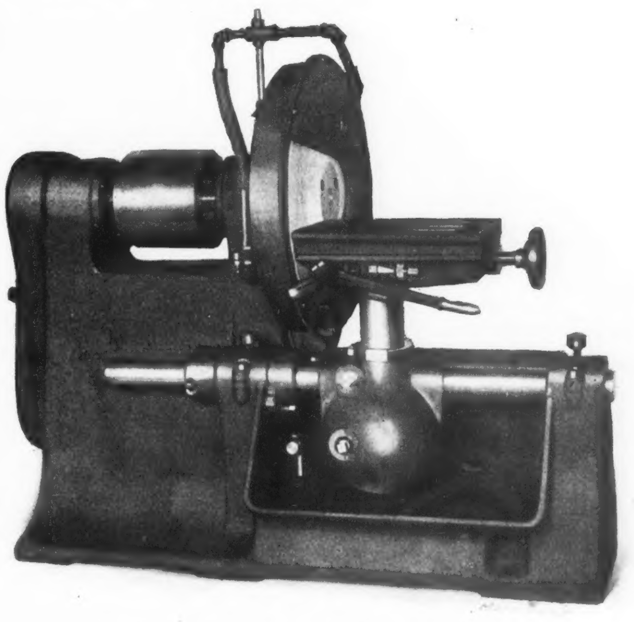


Fig. 1. Front View of Gardner No. 50 Disk Grinder

There are three ½-inch T-slots in the table and the working surface of the table is 18 by 10 inches in size. A channel surrounds the table, which is provided with the necessary pitch to carry the water off into a drainage basin when wet grinding is being done on the machine. The feed mechanism which moves the table toward the grinding wheel is a feature of the design of this machine. Provision is made for employing either lever, screw or spring-actuated feed. When the lever feed is employed, the screw wheel is disengaged by removing a taper pin which fits through its hub, so that the travel may be actuated by a pinion secured to the inner end of the lever shaft, which engages a rack secured to the under side of the table. The second handle mounted on the lever shaft, which projects toward the front, is for the purpose of assisting in rocking the table. The positive screw feed is obtained by replacing the taper pin in the hub of the wheel and turning the handwheel to the right. A spring pressure of from 1 to 300 pounds can be obtained by adjusting the screw handwheel when the latter is disengaged. When the spring feed is used, the hand lever is employed to secure any additional pressure which may be required, and for backing the table away from the grinding wheel. A micrometer stop-screw, shown in the front view of the machine, provides for accurately governing the forward movement of the table.

This machine may be equipped with either a 30-inch steel disk wheel or a 20-inch ring-wheel chuck. The abrasive wheel is used when it is desired to do wet grinding and the disk wheel when dry grinding is to be done. There are two openings at the bottom of the cast-iron hood, one of which is for the water and the other for the dust. When one of these openings is in use, the other is closed by means of a hinged cover. When the machine is used for wet grinding,

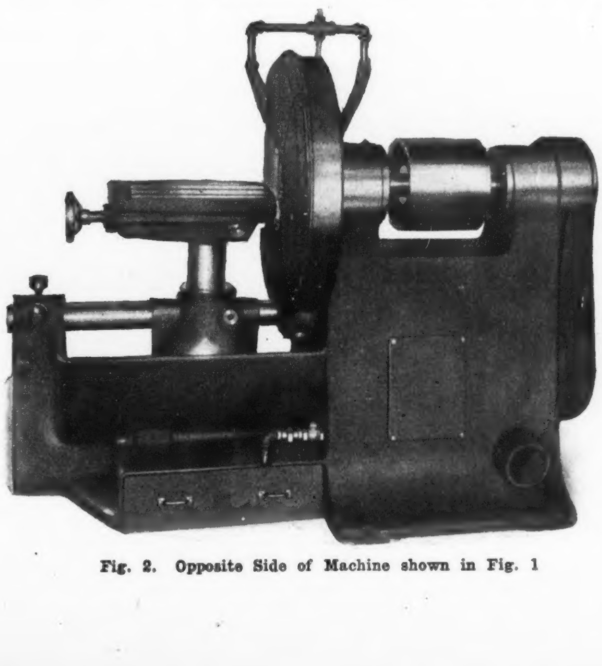


Fig. 2. Opposite Side of Machine shown in Fig. 1

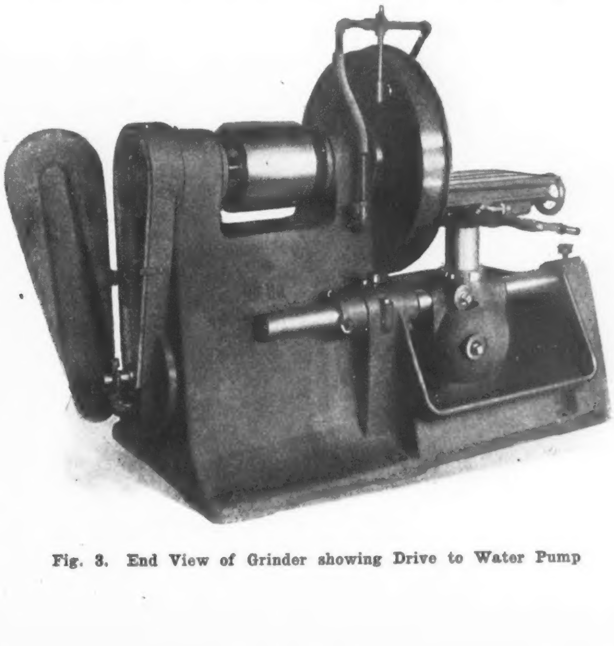


Fig. 3. End View of Grinder showing Drive to Water Pump

the water is carried off into a drainage basin from which it overflows into the removable reservoir which will be seen in the rear view of the machine; and from this reservoir it is pumped back to the grinding wheel. The water pump is of the geared type and is driven from the machine spindle by a sprocket-and-chain drive. The dust exhauster is contained within the base of the machine and is driven by a belt; it is connected with the bottom of the hood and discharges at a point near the base of the machine at the rear, where a thimble is provided for connection to the exhaust pipe. The front of the hood is enclosed with cast-iron sections which can be removed or inserted to make the opening of the required size for the work. The chain and belt which drive the water pump and exhauster, respectively, are enclosed by a cast-iron guard which has a hinged door to give access to the drive.

Fig. 4 shows the machine engaged in surfacing the bottoms of electric sad irons, and this operation reveals some interesting data. The area to be surfaced was approximately 21 square inches and the parts were ground on the Gardner No. 50 disk grinder at the rate of six per minute. In order to obtain comparative data, some of the same irons were ground on a Gardner No. 7 disk grinder of standard design, which is also equipped with a 30-inch disk wheel. On the latter machine it was only possible to finish two irons per minute. When grinding on this machine, there was also a

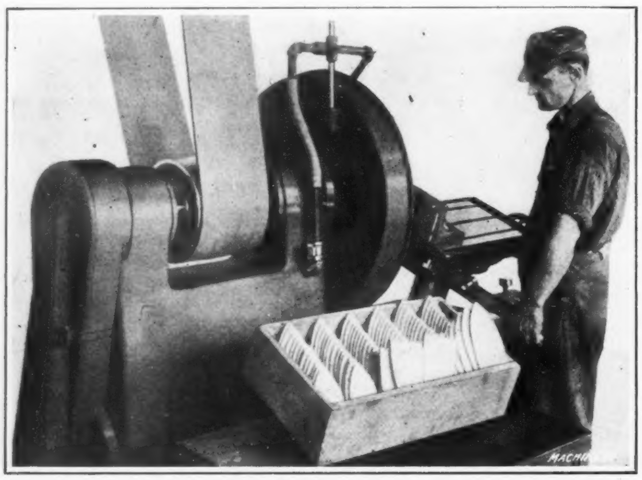


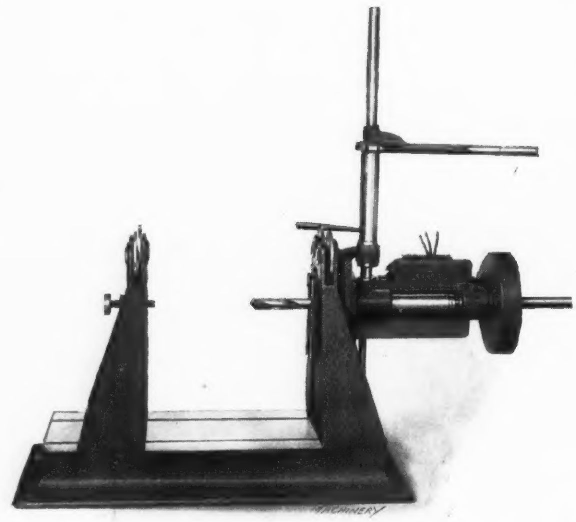
Fig. 4. Facing Electric Sad Irons on Gardner No. 50 Disk Grinder

tendency for the operator to merely grind through the scale on the work, but when the No. 50 machine was used more stock was frequently removed than was actually necessary to clean up the surface, owing to the rapidity with which the machine cut. As regards the relative cutting speeds of the two types of machines, it may be stated that the No. 50 machine will grind away twenty ounces of iron per minute, while the No. 7 machine only removes 4½ ounces of iron per minute.

## ROCKFORD COMBINATION DRILLING AND BALANCING MACHINE

The accompanying illustration shows a combination drilling and balancing machine which is a recent product of the Rockford Tool Co., Rockford, Ill. It will be seen that the shaft which carries the part to be balanced is supported by two pairs of hardened disks. These disks are mounted on standards which may be adjusted on the bed of the machine to give various distances between the standards up to thirty inches. The machine is intended for use in balancing pulleys and flywheels ranging from 10 to 18 inches in diameter, and it can be arranged either for individual motor drive or for belt drive.

This machine is very convenient to operate; the disks always remain true and do not require to be leveled up. The provision of the drill on the balancing machine does away with the necessity of removing the work from the standards and taking it to the drill after each test for balance has

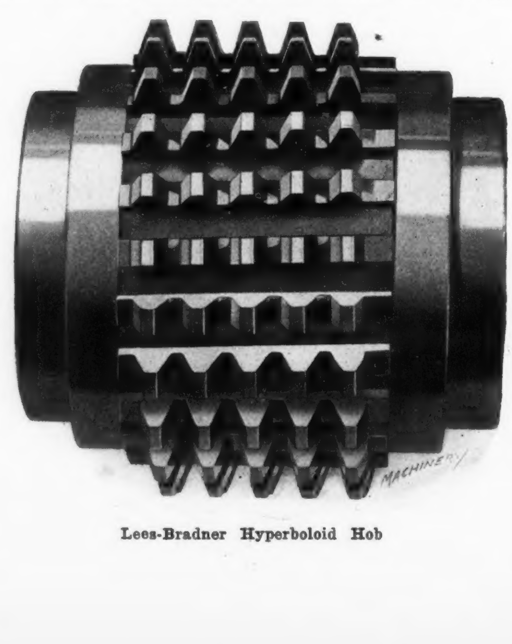


Combination Drilling and Balancing Machine made by the Rockford Tool Co.

been made. As a result, alternate drilling and balancing operations can be readily performed until the work is found to be perfectly balanced. An adjustable stop is provided which prevents the work from sliding up against either of the standards—a condition which would hinder it from revolving freely.

## LEES-BRADNER HYPERBOLOID HOB

For years the technical papers have discussed the merits of the hobbing process, pro and con; but much of the criticism of results obtained by the hobbing process has arisen either directly or indirectly from errors in the hob or from poorly designed hobbing machines. The fundamental principle of gearing must be observed in the case of gears produced on hobbing machines. Obviously, the bearing must be concentric with the pitch circle of the gear, and the sides of the teeth must be uniform if satisfactory results are to be obtained, but many writers have shown that the teeth of certain hobbed gears were not uniform, and that the pitch circle was not concentric with the bearing. These defects were due to errors in the hob and hobbing machines, respectively. In practically all cases the flats on the teeth of hobbed gears were caused by inaccuracies in the hob. These inaccuracies were due to the combined effect of theory and practice, *i. e.*, the outline of the hob was theoretically wrong, and it was found practically impossible to harden the hob without distortion. The gear hobbing machine must also be designed in such a way that it is powerful and rigid enough to take advantage of the multiple cutting edge of the hob. The Lees-Bradner Co., Cleveland, Ohio, which is a pioneer in the art of hobbing gears, has been making a careful study of this subject for a number of years, as a result of which the "hyperboloid"



Lees-Bradner Hyperboloid Hob

hob shown in accompanying illustration has been developed. The theoretical considerations calling for the use of a hob of this form are that the cutting edges of each series of teeth must enter and depart simultaneously on a theoretical line, which has been designated the "generating plane".

It will be apparent in a hob of the solid cylindrical type, which is fluted at right angles to the lead, that the row of teeth which is generating presents an elliptical outline to the gear being cut. In addition, the helical flute presents a warped surface with one end of the flute stubbed and the other end raked, as far as the generating plane is concerned. This can be readily seen if the fact is grasped that a section taken through a cylinder at right angles to the axis is a circle, that a section taken through a cylinder parallel to the axis is a rectangle, while a section taken through a cylinder at an angle to the axis is an ellipse. As a result, it will be evident that with the hob set at its working angle, an elliptical outline will be presented to the work. Therefore, to obtain a hob that will produce a rectangle under these conditions, it is necessary for the tool to be of hyperboloid outline. The hyperboloid hob developed by the Lees-Bradner Co., which is shown in the accompanying illustration, is made up of a series of high-speed steel racks which are ground for lead, side relief, top relief, and to provide sharp cutting edges. These racks can be renewed as they become worn out, and as the housing is hardened and the bore ground to a plug gage fit it will last indefinitely.

## HEALY VALVE TOOLS

For use in reseating motor valves the Healy Tool & Appliance Co., Buffalo, N. Y., is now manufacturing a set of

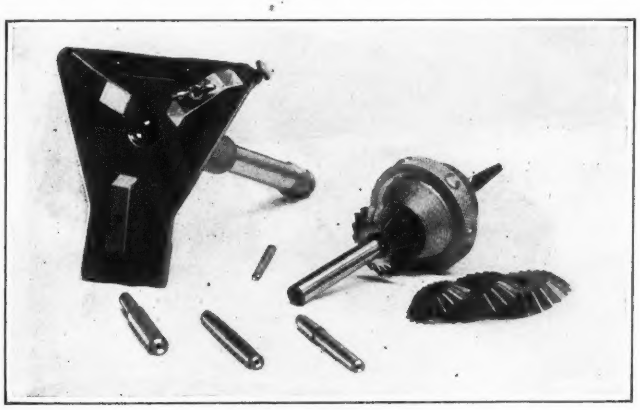


Fig. 1. Set of Healy Valve Tools

tools which is illustrated and described herewith. Fig. 1 shows the tools and Figs. 2 and 3 show the use of a face cutter in the dresser head, and of the seating cutter. The dresser head, shown in Fig. 2, has a tube to receive the valve stem and there is a long adjusting screw to form an end bearing. There is also an inside chuck which has a double-ended bearing, and by means of the adjusting mechanism this chuck is closed and locked onto the valve stem,

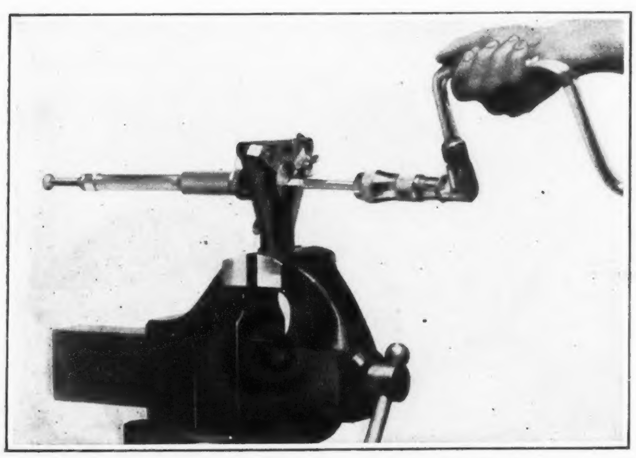


Fig. 2. Use of Face Cutter in Dresser Head

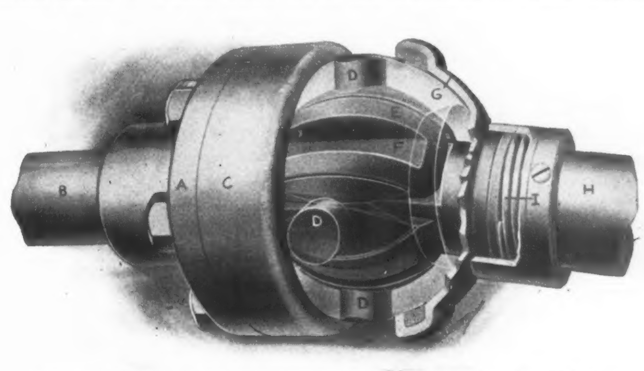
just permitting the stem to rotate with the bit-brace. The dresser head is provided with one guide and two face cutters which are set by micrometer screws, so that a very fine cut may be taken on the head of the valve.

Fig. 3. Way in which Seating Cutter is used

The seating cutters, one of which is shown in use in Fig. 3, are made of tool steel and have from 20 to 24 cutting edges, according to size. Means are provided to permit a cutter which is 1/4 inch larger than the valve to enter the port; a cutter the same size as the valve will not take off the shoulder, but a larger cutter will do so. The pilots are made of steel, ground to within 0.001 inch of the standard size and hardened to afford the required durability. The port steadyrest is an important feature of this tool; each end of the rest is made with a running thread on the taper so that the rest will engage a port of any size.

## COOPER UNIVERSAL JOINT

The Cooper universal joint, which is illustrated and described herewith, provides for securing absolute uniformity between the angular velocity of the driving and driven members at all points of the revolution. The driving member consists of a flange $A$ which is carried by the shaft $B$, with provision for locking the flange securely to the shaft. A shell $C$, which is spherically shaped internally, is fastened to flange $A$ by means of a dovetailed spline and from two to eight hexagonal headed cap-screws, according to the size of the joints. There are four holes spaced 90 degrees apart in this shell, and four V-shaped trunnions $D$ are inserted in these holes. The driven member of the joint consists of four cross-heads $E$ which have three flat surfaces at right angles




Cooper Universal Joint which provides a Uniform Angular Velocity between Driving and Driven Members at All Points of the Revolution

to each other, while the remaining surface is spherical. These cross-heads are inserted in the spherical-shaped shell $C$ so that they come between the four trunnions $D$ and leave a square opening from the shaft. The backs or spherical shaped sides of the cross-heads are grooved at $F$ to form recesses for a sufficient volume of lubricant to last for one year. A cover $G$ mounted on a squared driven shaft $H$ and held against the exterior of the shell by a spring $I$ serves to exclude dust and retain the lubricant in the joint.

In operation, the cross-heads $E$ oscillate between the trunnions $D$ and against the spherical interior of the shell $C$, the movement being through a number of degrees corresponding to the included angle between the shafts. Owing to the large flat driving surface, ample lubrication and slight movement of the parts, friction losses are prac-

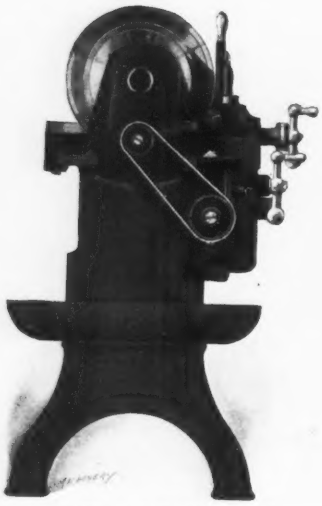


Fig. 1. End View of Rockford Lathe

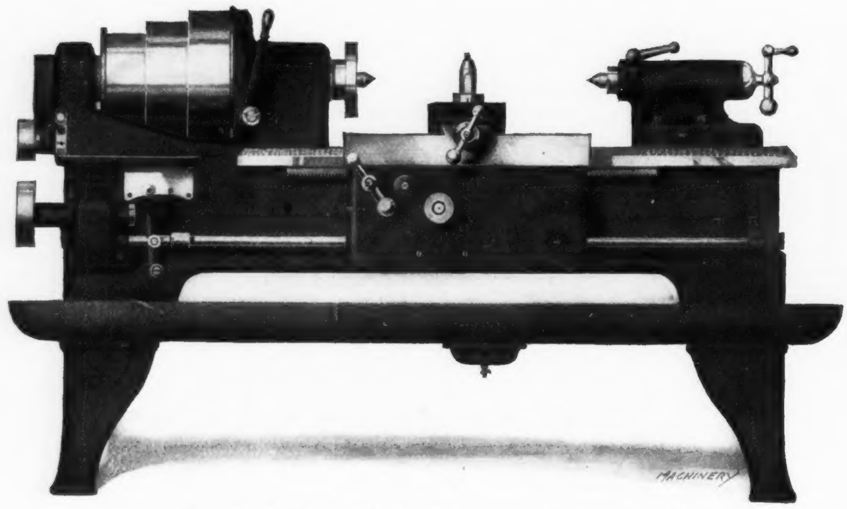


Fig. 2. Rockford 16-inch High-power Manufacturing Lathe

tically negligible. Varying the angle of this joint does not cause the driving or driven member to shorten centers during a revolution, and as a result the angular velocity of the driven member is the same as that of the driving member at all points during each revolution. Consequently, the use of the second compensating joint is unnecessary. All working parts of the joints are made of hardened steel and ground to size so that satisfactory wearing properties are assured. This universal joint is made by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y.

## ROCKFORD 16-INCH LATHE

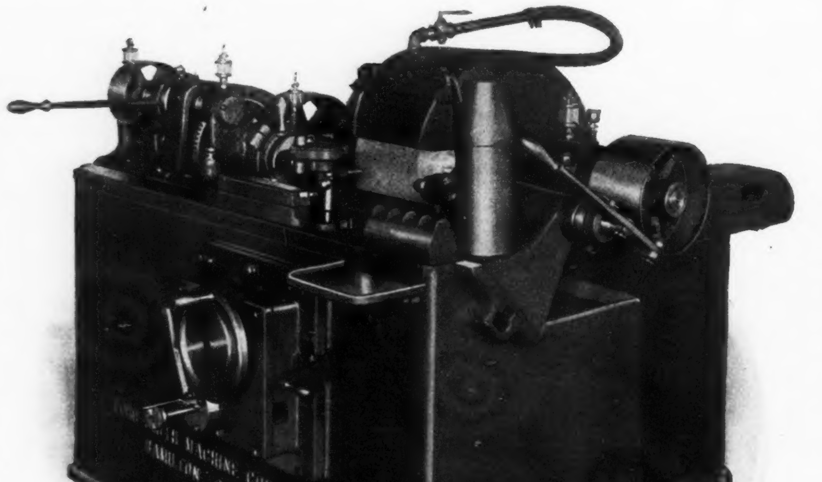
The design of the 16-inch high-power lathe which has been placed on the market by the Rockford Tool Co., Rockford, Ill., has been particularly worked out to meet the requirements of those manufacturers who produce duplicate parts in large quantities. To adapt the machine for heavy work, the headstock is ribbed to provide ample rigidity, and the spindle is made from a crucible steel forging. The spindle bearings are provided with babbitt metal liners which are seated in dovetailed slots; the front bearing is 2¾ inches in diameter by 6¼ inches long. An oiling system supplies lubricant to all the bearings.

The manipulation of a single lever operates a powerful friction clutch and also applies a brake which stops the spindle almost immediately. The bed is of deep section and adequately ribbed; especially wide V-bearings are provided. The tailstock is clamped by two bolts, and to provide for taper turning operations, the tailstock may be set over. The carriage has a wide bearing surface, and the apron is heavy and deep. A heavy plain rest is regularly furnished which has a dovetail slide 7½ inches wide. This slide has tapered gibs which affords a means of compensating for wear. A large dial graduated in thousandths of an inch is mounted on the cross-feed screw. Power longitudinal feed is provided with four quick changes; the cross-feed is operated by hand. A large pan for oil and chips is regularly furnished with this lathe. The drive is from a two-speed friction countershaft which should be arranged to run at from 80 to 225 R. P. M. The countershaft pulley is 14 inches in diameter and carries a belt 4 inches in width.

The principal dimensions of this machine are as follows: Hole through spindle, 1 7/16 inch in diameter; swing over bed, 16½ inches; swing over plain rest, 8¼ inches; maximum distance between centers for a machine with a 6-foot bed, 2 feet 2 inches; length of carriage, 24 inches; width of cross-slide, 7½ inches; and weight of machine with 6-foot bed, 2200 pounds.

## FORD-SMITH SHRAPNEL SHELL GRINDER

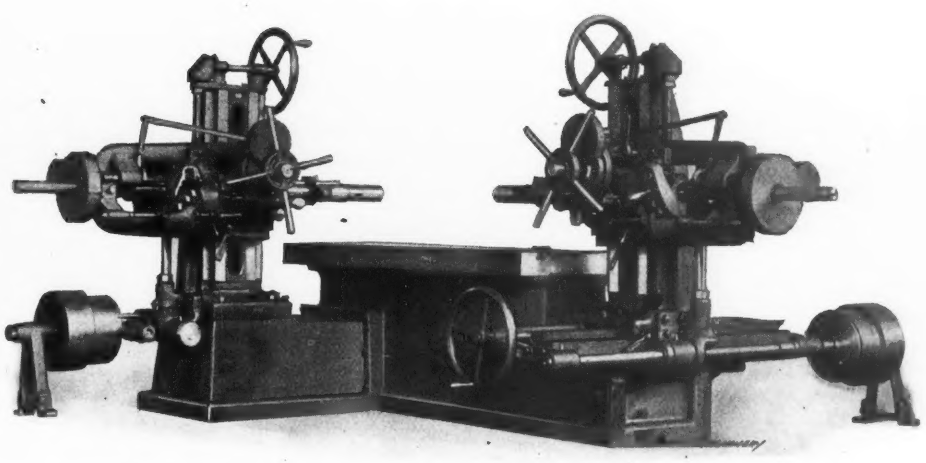
The accompanying illustration shows a heavy type of wide-wheel grinder which has been developed by the Ford-Smith Machine Co., Hamilton, Ontario, Canada, for use in grinding shrapnel shells, high-explosive shells, and other types of wide-wheel work which come within its range. The machine is especially adapted for grinding shrapnel shells in a single operation, and is designed along lines which provide for obtaining the maximum output from the best abrasive wheels. It will be obvious that the power requirements of the machine for driving both the wheel-spindle and work-spindle are unusually high, and to provide an abundance of power the wheel-spindle is driven by two 6-inch belts, while the work-spindle is driven by a 4-inch belt and a 1 to 4 geared drive. During the early stages of the development of this machine, trouble was experienced in obtaining suitable formed grinding wheels, but several manufacturers are now producing grinding wheels which cut freely and hold the required shape for a reasonable length of time. It is stated that 65 shells can be ground accurately to gage without truing the wheel, and where the wheel is touched up occasionally with a hard dresser, without the use of a diamond, it is possible to grind 150 shells.



Ford-Smith Heavy Type of Wide-wheel Grinder for finishing Shrapnel Shells

This machine pro-

vides for finishing the outside of the shell at a single operation, and the work is perfectly concentric, symmetrical, and true to shape and size. The machine can be operated by unskilled labor, and the expense of diamonds for truing the wheels has been largely eliminated through the use of a hard dresser for keeping the wheel in condition. In the article entitled "Shrapnel and Shrapnel Manufacture", published in the April number of MACHINERY, a complete description was given of the method of truing the wheel. The equipment of the machine includes a pump, tank, water connections and a formed truing device for the grinding wheel. The principal dimensions of the machine are as follows: Height from floor to center of spindle, 39 inches; diameter of grinding wheel, 20 inches; width of form face of wheel, 8¼ inches; diameter of wheel-spindle bearings, 3⅜ inches; diameter of headstock bearings, 4 inches; length of headstock bearings, 7½ inches; length of bed, 5 feet 6 inches; width of bed, 5 feet; speed of wheel countershaft, 575 R. P. M.; speed of work countershaft, 275 R. P. M.; power required to drive the machine, 25 horsepower; and net weight of machine and countershaft, 7500 pounds.



Rockford Double-head Boring, Drilling and Tapping Machine with Spindles set at Right Angles

## ROCKFORD BORING, DRILLING AND TAPPING MACHINE

The double-head horizontal boring, drilling, and tapping machine which is illustrated and described herewith is a recent addition to the line of the Rockford Drilling Machine Co., Rockford, Ill. This machine is built in two different types, one of which has the right- and left-hand heads arranged as shown in the illustration, with the spindles at right angles to each other. The other type of machine is built with the right- and left-hand heads at opposite ends of the bed, so that the spindles are opposed to each other. Both types of machines are made in three different styles, one of which has both heads arranged with a lateral adjustment of 36 inches and a vertical adjustment of 18 inches; another, which has both heads provided with only vertical adjustment; and a third style in which one head is provided with both vertical and lateral adjustment, while the other head has only the vertical adjustment.

The machines have a capacity for driving high-speed drills up to 3 inches in diameter, and boring tools up to 8 inches in diameter when boring out cored holes in cast iron. The principal dimensions are as follows: Diameter of spindle, 2 1/16 inches; diameter of spindle sleeve, 3⅜ inches; maximum spindle travel, 25 inches; hole in spindle, bored No. 5 Morse taper; and size of table, 24 by 72 inches. There are eight changes of feed, any of which is instantly obtainable. There are four different drives. In one style of drive there is a two-, three-, or four-step cone pulley; in the second style, the machine is equipped with a tight and loose pulley and a gear-box which gives eight changes of speed; in the third style, the drive is through a constant-speed motor and gear-box; and the fourth style of drive is from a variable-speed motor.

## FOX MILLING MACHINE

In the No. 3½ milling machine made by the Fox Machine Co., 641 Front Ave., N. W., Grand Rapids, Mich., both hand and power feed are provided; the machine is suitable for a variety of light tool work and manufacturing operations which come within its range. Micrometric dials are provided on the screws which govern the vertical and transverse movements. Both the front and rear spindle bearings are of hard bronze which possesses excellent wearing properties, and each bearing is independently adjustable. The thrust is carried on the main column, and as it is transmitted through the driving cone, none of the thrust is carried by either of the bearings.

The saddle is made exceptionally long, being designed to afford a maximum rigidity; and the table has been made proportionately heavy so that vibration is reduced to a minimum. The knee bearing is extended so that it comes practically flush with the top of the table, and this extended bearing, in addition to having a tendency to reduce vibration, provides additional strength for the knee. The knee is raised and lowered by a telescopic screw which does not require a hole to be cut in the floor. A locking-screw is provided on the dial which enables it to be loosened so that it can be set back to zero, after which the screw is retightened and the table raised or lowered, as may be required. The design of the feed mechanism has been carefully worked out to combine the features of simplicity and durability. The regular equipment furnished with the machine consists of an overhanging arm, a plain countershaft and a suitable equipment of cranks, wrenches, levers, etc. Either a ⅞- or 1-inch arbor is provided with the machine.

Fox No. 3½ Milling Machine with Hand and Power Feed

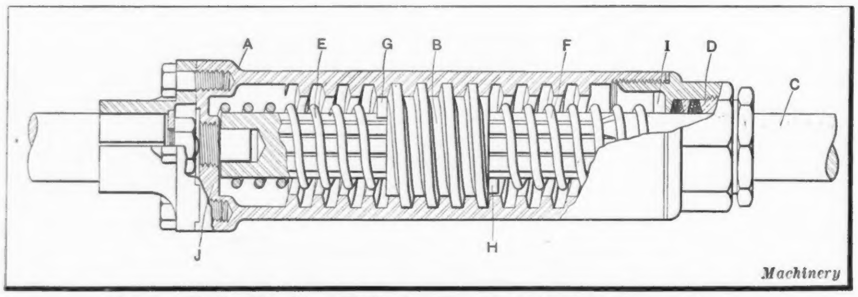
The principal dimensions of this No. 3½ milling machine are as follows: Automatic longitudinal movement in either direction, 18 inches; transverse movement, 6 inches; vertical movement, 16 inches; maximum distance from table to spindle, 15½ inches; size of working surface on table, 6 by 20 inches; and taper hole in spindle,

No. 9 Brown & Sharpe. The machine is provided with six available feeds of 0.003, 0.005, 0.006, 0.007, 0.010, and 0.014 inch per revolution of the spindle, and the available spindle speeds range from 21 to 425 revolutions per minute. The net weight of the machine, including countershaft and other equipment regularly provided, is 855 pounds.

## COOPER SHOCK ABSORBING SHAFT

The shock absorbing shaft which forms the subject of this article has been developed by the Cooper Flexible Transmission Co., Inc., 8th Ave. and 18th St., Brooklyn, N. Y., for the purpose of supplying a simple mechanism which is applicable for use in connection with all forms of power transmission systems where a gradual application of power is desirable. The construction of this device and the principle on which it operates will be readily apparent by referring to the accompanying illustration. For convenience of explanation it will be assumed that the case *A* is the driving member. This case is threaded internally to receive a worm *B* that is carried by the splined shaft *C* which extends through the stuffing-box *D* at the end of the case. Two springs *E* and *F* are mounted on each side of the worm, one end of each spring being engaged by the projections *G* and *H* on the worm, and the opposite ends by the projections *I* and *J* on the stuffing-box and at the bottom of the case, respectively. The case is filled with oil and an adjustable by-pass is provided through the worm. When the case or driving member *A* is rotated, it will be found that the worm *B* moves toward the solid end of the case. This results in the displacement of the oil, which escapes through the by-pass to the opposite side of the worm, and at the same time the spring *E* is wound up.

During the initial part of the movement, the driven shaft *C* remains stationary and continues to do so until the combined pressure of the worm on the oil and the tension of spring *E* exactly balance the torque which is required to start shaft *C* rotating. After starting the rotation, the speed of the driven shaft will be gradually accelerated until it reaches its normal speed. As soon as shaft *C* has reached its maximum speed—which is slightly in excess of the normal speed—a reaction takes place and the starting torque is reduced to the normal running torque. This allows the worm *B* to move slightly toward the right-hand end of the case, thus reducing the pressure on the oil and the tension of spring *E* sufficiently to reduce the torque and running speed to the normal condition. The absence of sudden strains in starting reduces the amount of wear and tear on all parts of the transmission system. This device is primarily intended for use on automobiles, and in such cases it is built right into the transmission. It is also suitable for drives that transmit power to many types of machines, and wherever it is used it will be the means of eliminating vibration and wear due to the sudden application of the drive.



Cooper Shock Absorbing Shaft for Use in Automobile Transmissions, Hoisting Machinery, Spinning Frames, etc.

## VICTOR SHRAPNEL SHELL TAP

For use in machining shrapnel shells to receive the timing fuse, the Victor Tool Co., Waynesboro, Pa., has developed a collapsible tap which is shown in the accompanying illustrations. The body of this tool is made of a tough grade of machine steel which gives plenty of strength to enable it to stand up under the conditions of rapid production which are usually maintained in factories working on ammunition orders. The chasers are adjusted by the hardened set-screw *A* at the front end, which has 32 threads per inch, so that very fine adjustments may be made. After the chasers have been set to size, they are rigidly clamped in such a way that there is no chance of their slipping. The screw *B* at the rear end of the holder adjusts the tension of the spring which controls the tripping device.

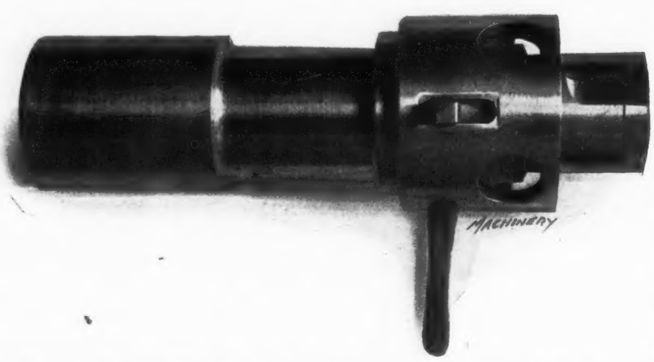


Fig. 1. Victor Collapsible Tap used in machining Shrapnel Shells

All parts of the tap which are subject to wear are hardened and ground. The chasers are of high-speed steel and are made exceptionally heavy to stand up under the strains which exist in cutting shrapnel or high-explosive shells made of crucible steel. This tap may be used in either a turret head or in the lathe spindle, and gives equally satisfactory results in either type of machine. In operation, the tap is fed in until the collar is engaged by the work. This releases the tripping device and allows the spring to draw back the central plug *C*. The result is that the chasers are moved in toward the axis of the holder so that the tap may be withdrawn from the work. The tool is reset by moving the lever *D* forward to the position shown in Fig. 2, which expands the tap and locks the chasers in place ready for taking the next cut.

## DYNAMIC BALANCING MACHINE

In order to bring a body into dynamic balance, the following principles must be observed: First, a body cannot be in dynamic balance unless it is also in static balance, and the first step is to secure a condition of static balance. This simply means that the center of gravity of the body must be made to lie on the axis of rotation. Second, a body which is statically balanced can be brought into

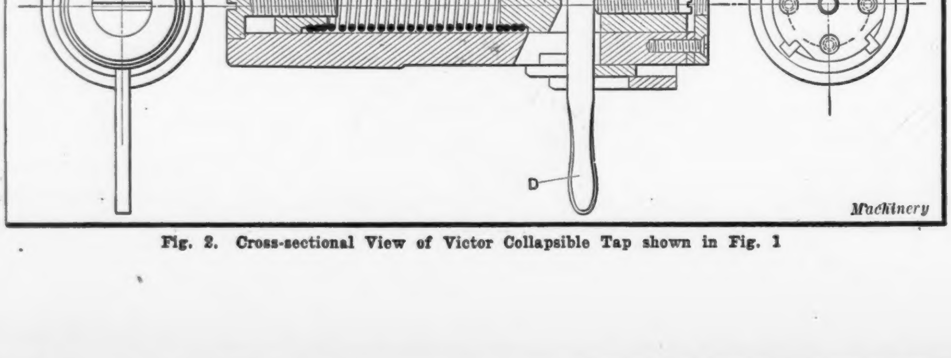


Fig. 2. Cross-sectional View of Victor Collapsible Tap shown in Fig. 1

dynamic balance by introducing a so-called "centrifugal couple", *i. e.*, by adding two weights or drilling two holes in the plane in which the disturbing centrifugal couple is acting. In special cases, such as a three-throw crankshaft, it may be necessary to split up one of the weights or holes between two adjoining cranks so that the resultant added weight or drilled hole will be in the same plane with the other weight or hole and the axis of rotation of the body. These principles have been applied by the Dynamic Balancing Machine Co., Philadelphia, Pa., in the development of the machine which forms the subject of this article.

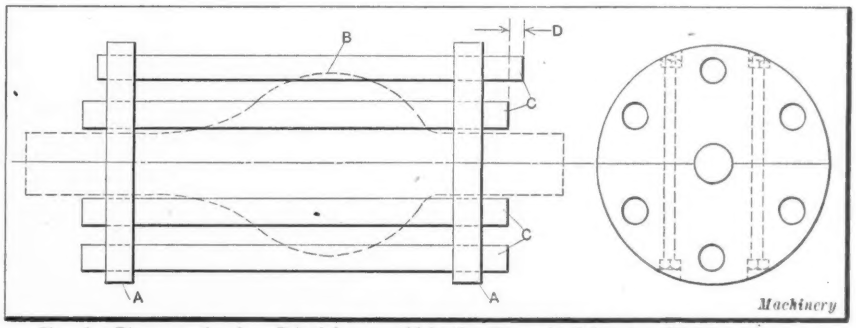


Fig. 1. Diagram showing Principle on which the Dynamic Balancing Machine operates

In this machine the balancing device consists of a so-called "squirrel-cage" system made up of two or more disks *A* which are made in halves and fitted over the unbalanced body *B*, that is indicated by the dotted lines in Fig. 1. To explain the action of the device, imagine an even number of rods *C* to be located at the same radial distance from the axis of rotation, all of the rods being of the same weight and size. Under these conditions the cage is perfectly balanced so that any lack of balance can only be due to the body *B* which is under test. It will be evident that if means are provided to bring about a condition of perfect dynamic balance by moving one of the rods *C* through some distance *D*, it would enable us to know the exact value of the necessary centrifugal couple which must be introduced by drilling or adding weights in order to secure a perfect condition of dynamic balance in the body *B*. Knowing the weight of each rod, its radial distance from the axis, and the necessary displacement *D* that is required to bring the system into a condition of dynamic balance, all of the necessary data is available. The product of these three quantities is the required centrifugal couple, and any oppositely applied centrifugal couple of the same numerical value will place the system in a condition of dynamic balance, *i. e.*, it will then run true when all the rods *C* are kept central.

In drilling the holes in the body or adding weights to bring it into a condition of dynamic balance, there is only one condition to be considered; *i. e.*, that the resultant centrifugal couple which is introduced must be numerically equal to the value determined by moving one of the rods *C*. There are three elements to be considered: The change of weight to be brought about by drilling or adding material; the distance from the axis at which metal is added or removed; and the longitudinal distance of this point from the corresponding point at the opposite side of the body. These conditions can be made to suit the practical requirements of each case, so that there are a great variety of solutions for any given problem. It will be seen that the relative longitudinal position of the rods *C* in the cage does not alter the static balance of the system, and that the displacement of the rods not only locates the plane of unbalance, but also the exact numerical value of the correction which must be made. With a cage comprising six rods, the body can be balanced in only three planes located 120 degrees apart; and with a greater number of rods the body can be balanced in a correspondingly greater number of planes. In practice, it is so easy to fix the cage around the body in some other position than that in which the test has already been made, that the number of rods can be kept down to three or four.

Fig. 2 shows the method of procedure in testing a crankshaft and flywheel for a six-cylinder motor. In this illustration, the cage is clearly shown at the center of the shaft. Means of moving the rods *C* to and fro while the system is revolving are provided by means of compressed air nozzles supplied from pipe *E* which deliver the air against the small fans *F*, one of which is located on each rod. There are three pairs of fans located in corresponding positions on opposite rods, and independent valves *G* control the air delivered from the respective nozzles to each pair of fans. The holes in the disks *A* are tapped to receive the threaded ends of the rods *C*. Lack of space makes it impossible to refer to all of the refinements which are provided. This machine is suitable for use in balancing a great variety of parts, such as turbo-rotors, armatures, pulleys, propellers, crankshafts, etc.

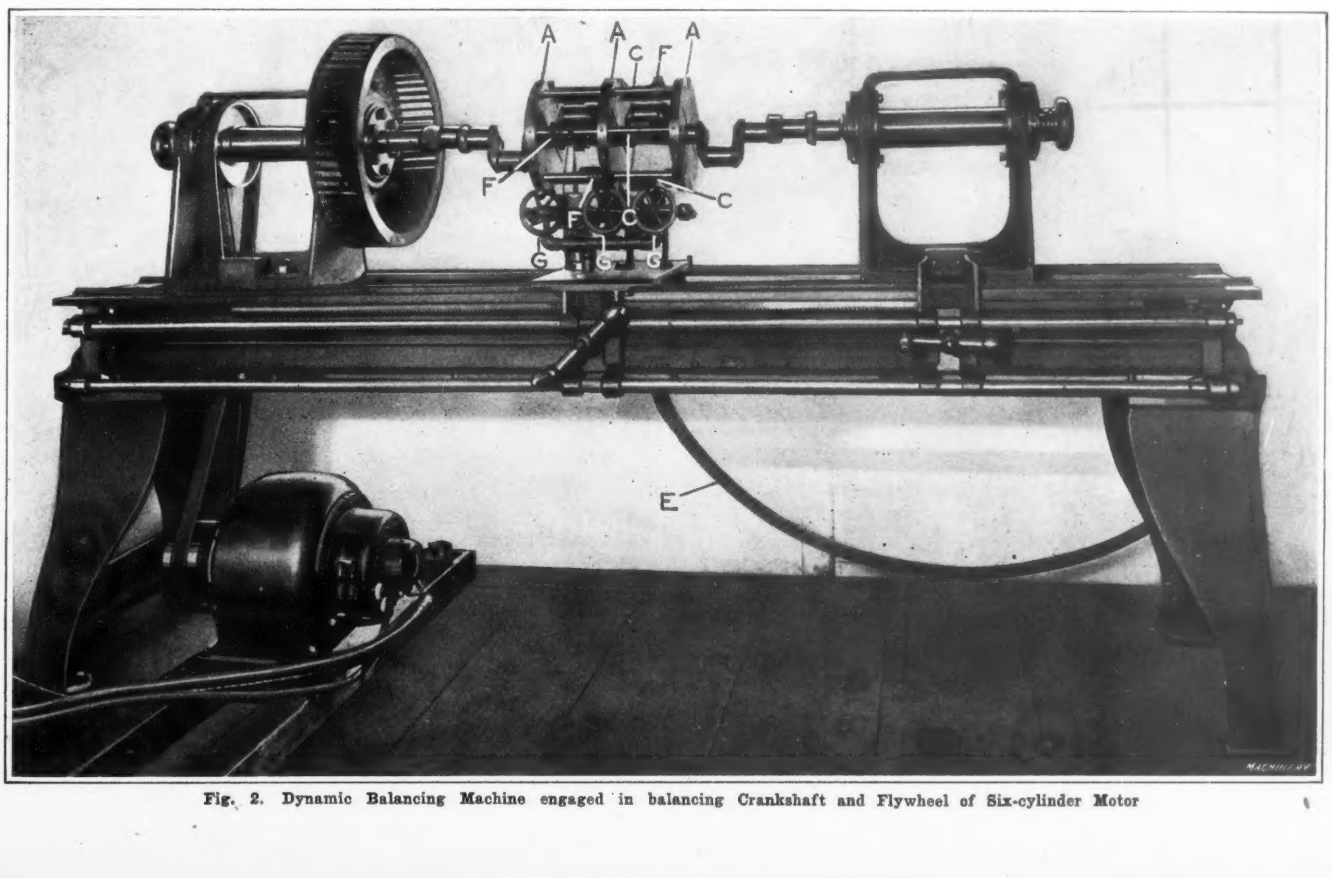


Fig. 2. Dynamic Balancing Machine engaged in balancing Crankshaft and Flywheel of Six-cylinder Motor

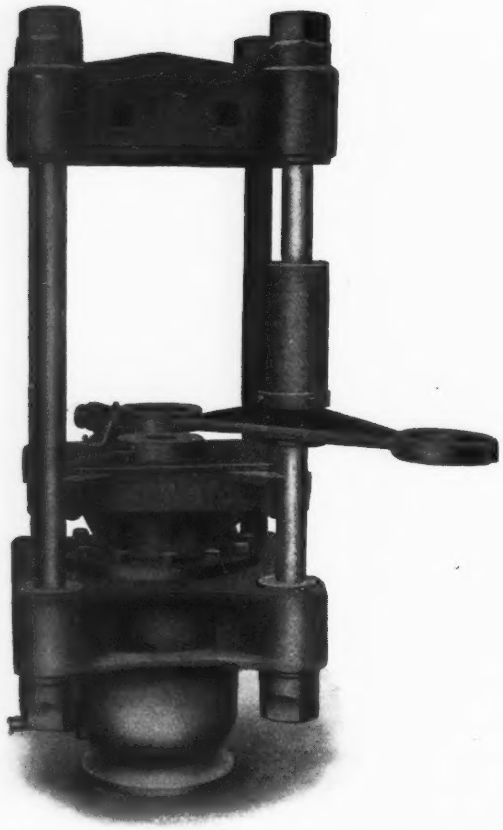


Fig. 1. Shrapnel Shell Nosing Press made by the Hydraulic Press Mfg. Co.

## HYDRAULIC NOSING AND BANDING PRESSES

For finishing steel shells after they have been forged and drawn into shape, two pressing operations are required, *i. e.*, the shells must be subjected to a "nosing" operation in which the end of the shell is partially closed in, and then the copper band must be shrunk around the shells. The Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, Ohio, is now building two hydraulic presses for performing these operations. The nosing process is illustrated in Fig. 1; and Fig. 2 shows the press for shrinking the copper band onto the shells.

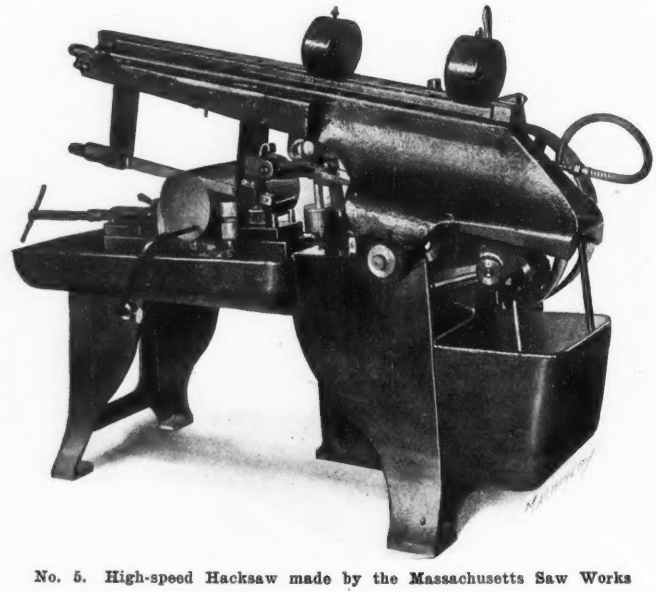
Reference to Fig. 1 will show that the nosing press is of the upward pressure type. After the shells have been formed from the solid billets, drawn into shape and partially machined, the ends of the shells are heated and the shell is placed in a centering die on the platen of the press. A die having a conical shape to correspond with the nose of the finished shell is attached to the head of the press. As the ram rises, the shell is forced into this die and the edges are turned in to form the nose or point of the shell. A revolving loading attachment is carried on one of the strain-rods, and as a result, the operator can be setting up a shell in the outer end of the loading attachment while the press is working on another shell. This press is capable of exerting a maximum pressure of 150 tons; and to enable it to stand up under this severe strain, steel is used throughout the construction. The press is operated either direct from an individual pump or from an accumulator system.

Fig. 2. Shrapnel Shell Banding Press made by the Hydraulic Press Mfg. Co.

After the nosing operation has been completed it is still necessary to shrink the copper band onto the shell, and for this operation the Hydraulic Press Mfg. Co. has developed the four-cylinder horizontal hydraulic press shown in Fig. 2. It will be seen that the rams from four cylinders operate in the direction of a common center, which results in compressing the band from four sides. In order to secure the band properly at all points, the shell is turned two or three times during the pressing operation. From 20 to 75 tons pressure is necessary for performing this work. During the pressing operation, the shell is supported in the center of the press by a detachable table or stand. This press will develop a pressure up to 75 tons.

## MASSACHUSETTS HIGH-SPEED HACKSAW

The No. 5 high-speed hacksaw machine which is illustrated and described herewith is a recent product of the Massachusetts Saw Works, Springfield, Mass. The machine is particularly designed for the rapid cutting of all metals in sizes up to 9 by 9 inches and is heavily constructed with all intricate mechanism eliminated, so that the necessary strength and durability are provided. The machine is set low on a solid foundation with wide-spread legs to give the maximum rigidity and steadiness. The bed of the machine is surrounded by a pan which is provided with a 9-gallon tank covered by a screen to exclude chips. The tank, pan, bed and legs are cast in a single piece. The head of the machine, which carries all working parts, swings on a shaft-center, and the design has been worked out in such a way that a very steady silent motion is obtained. Particular attention has been paid to the provision of means for lubricating all working parts.



No. 5. High-speed Hacksaw made by the Massachusetts Saw Works

The manufacturers of this machine state that the trials to which it has been subjected have shown that the tendency to break the saw blades before they are worn out is practically eliminated. This is largely due to the smoothness and accuracy of the stroke, resulting from the extreme rigidity of the machine, which is an important factor in assisting the shock-absorber to take up vibration. Means are provided for lifting the saw clear of the work on the idle or non-cutting stroke. The principal dimensions of the machine are as follows: Capacity for cutting stock up to 9 inches square; size of blades used, from 12 to 17 inches in length; size of pulleys, 16 inches in diameter by 3 inches face width; floor space occupied, 5 feet 3 inches by 2 feet 8 inches; and weight of machine 845 pounds.

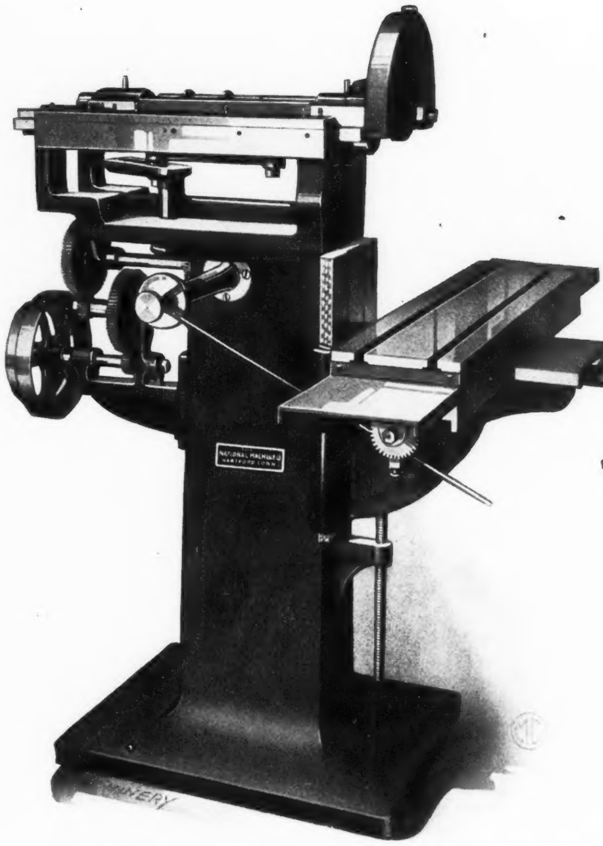


Fig. 1. "Hartford" Surface Grinder provided with Automatic Feed in Either Direction

## "HARTFORD" SURFACE GRINDER

The accompanying illustration shows the "Hartford" surface grinder which is manufactured by the National Machine Co., Hartford, Conn. This machine is suitable for grinding and finishing flat surfaces on punches, dies and hardened machined parts where the finished surfaces are required to be flat and true. The machine is said to have a high productive capacity and to produce very accurate work. Reference to Fig. 1 will show that the wheel-spindle is carried by a horizontal slide, with provision for giving the wheel a reciprocating travel across the face of the work. The arrangement of the drive for transmitting power to the crank, which actuates the movement of the wheel-slide, will be evident from the illustration. It will also be noticed that the work table provides for movement in three directions. The wheel cuts easily and wears evenly.

By moving the crankpin in the slotted crank on the under side of the wheel-slide, the length of stroke of the wheel may be quickly adjusted. The wheel-spindle runs in phosphor-bronze bearings mounted in the slide, and there are guards over the ways to prevent them from being damaged by dust and grit. The work may be held to the table by means of adjustable clamps; and in some cases, it is found desirable to use a regular milling machine vise or a special work-holding fixture. The machine is made in two sizes which will grind work to 8 inches wide by 18 inches long by 12 inches high, and 14 inches wide by 32 inches long by 12 inches high, respectively. In both cases, the height of 12 inches is based upon the use of an 8-inch wheel. The countershaft which drives the machine is equipped with tight and loose pulleys 6 inches in diameter by 3½ inches face width, and should run at 350 revolutions per minute. The net weight of the No. 1 machine is 900 pounds, and the No. 2 machine has a net weight of 1200 pounds. These grinding machines are used extensively for sharpening powder cutter knives, and when used for this purpose, they are equipped with the special attachment shown in Fig. 2.

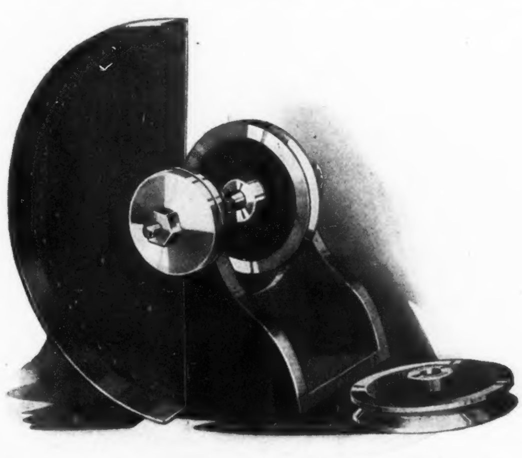


Fig. 2. Attachment for "Hartford" Surface Grinder for sharpening Powder Cutter Knives

## KEYES-DAVIS SCRAP REEL

The Davis automatic scrap reel, for winding up the scrap from punch presses so that it may be conveniently handled, is manufactured by the Keyes-Davis Co., Inc., Battle Creek, Mich. These reels reduce the amount of labor required to operate punch presses, and where they are employed one operator can attend to several presses equipped with automatic feeds. The machines are kept running continuously on blanking operations, and the punches and dies are safeguarded by a device which stops the press instantly in case the strip of scrap metal is broken, so that the press tools cannot be damaged by the scrap piling up between the punch and die. On blanking operations where ribbon stock is used, all the operator has to do is to put the coil of material on the stock reel at the left-hand side of the press, run it through the automatic feed rolls and attach the opposite end to the reel at the right-hand side of the press. When the feed rolls release the end of the strip, the reel speeds up and the press is instantly stopped.

Fig. 1. Keyes-Davis Scrap Reel set up on a Punch Press

It takes only 1½ to 2 minutes to remove the scrap and put on another reel, and as a result one operator can attend to a number of presses, depending on the length of the stock and the rapidity with which it is run through the dies. Under average working conditions, the operator can look after from five to eight presses, so that the labor cost is very low. Fig. 1 shows a Davis automatic scrap reel attached to a power press, and the way in which the mechanism oper-

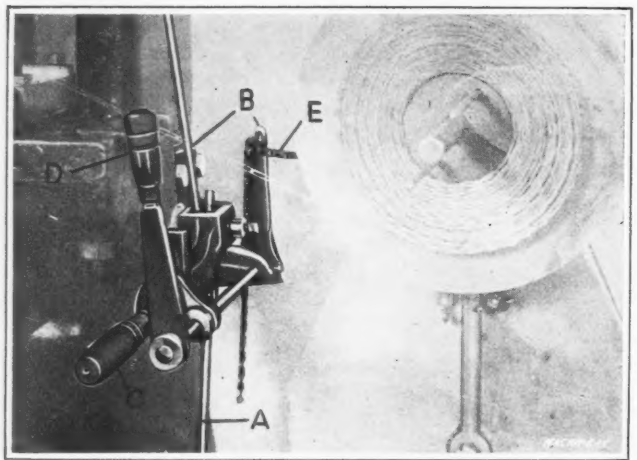


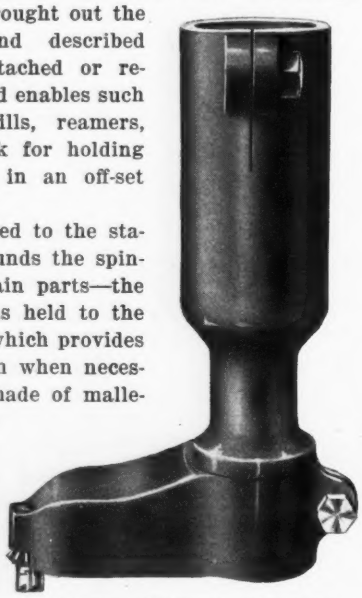

Fig. 2. Details of Operating Mechanism

ates will be readily understood by reference to Fig. 2 in connection with the following description:

In this illustration the clutch-operating rod which makes connection with the foot-treadle is shown at *A;* the bracket bolted to the side of the press at *B;* the starting lever at *C;* stopping lever at *D;* and the stopping lever operated by a chain from the clutch on the reel at *E*. In case the strip of scrap breaks, lever *E* operates to stop the feed. This scrap reel may be readily attached to any type of power press and it is capable of handling scrap up to 3½ inches in width. The starting lever *C* supplements the foot-treadle and makes it possible to start the press either by hand or foot. The press can be instantly stopped by means of lever *D*. This scrap reel is adjustable both vertically and horizontally, and it can be tilted to any angle to which an inclinable press may be set. The spring by which the reel is operated must be kept wound up by the belt shown in Fig. 1, the clutch connecting the pulley with the winding mechanism being controlled by a lever shown at the right-hand side of the reel.

## OFF-SET DRILL PRESS ATTACHMENT

To provide for performing various operations with a drill press in a position that could not be reached by a tool mounted directly in the spindle, the Off-Set Tool Co., Bridgeport, Conn., has recently brought out the attachment illustrated and described herewith. It is easily attached or removed from the machine and enables such tools as counterbores, drills, reamers, milling cutters, or a chuck for holding various tools, to be used in an off-set position in the drill press.



Drill Press Attachment made by the Off-Set Tool Co.

The attachment is fastened to the stationary sleeve which surrounds the spindle and consists of two main parts—the body and arm. The arm is held to the body by a clamping screw which provides for the use of a longer arm when necessary. The attachment is made of malleable iron, with hardened steel gears and bronze bushings. It is made in three sizes. These are designated as the A-1, A-2 and A-3 sizes, and have minimum arm lengths of 2, 3, and 4 inches, respectively. The cutting tool is held by a slot and set-screw, and is centered by the shaft which passes through the bevel pinion. This tool saves considerable time when the work is of such a character that it can not be reached by a tool mounted in the usual way.

* * *

The yearly index to the twenty-first volume of MACHINERY, completed with the August number, is ready for distribution, and copies will be sent to any address on receipt of request.

## NEW MACHINERY AND TOOLS NOTES

**Engine Lathe:** Putnam Machine Co., Fitchburg, Mass. A 42-inch lathe intended for use on exceptionally heavy reduction work and especially for the machining of heavy forgings. The machine is of unusually heavy construction, and it is claimed that it will work high-speed steel cutting tools to the limit of their capacity.

**Dust Collector:** Whiting Foundry Equipment Co., Harvey, Ill. This device is used for collecting the dust from tumbling mills, emery wheels, sand-blast equipments, etc. Cloth-screen dust arresters are employed inside of a sheet metal case, which are relied upon to remove the dust from the air and still allow the air to pass through freely.

**Self-Adjusting Wrench:** Hayward Wrench Co., St. Louis, Mo. A self-adjusting pipe wrench in which the movable jaw is operated by a link mechanism which gives an almost parallel motion. The wrench may be adjusted so rapidly that it is said to constitute almost the equivalent of a ratchet. It is suitable for use on bolts, nuts and pipe.

**Cutting-off Machine:** Williams Tool Co., Erie, Pa. A special cutting-off machine designed for facing the bottom or closed end and cutting off the ragged end of 4½-inch shrapnel shells. The machine is of rugged construction, to enable it to stand up under the severe conditions of rapid production for which it is intended. The weight is 3800 pounds.

**Shell Turning Lathe:** Amalgamated Machinery Corporation, Chicago, Ill. On this machine both the headstock and the tailstock are cast integral with the bed; and the bed is heavily ribbed to provide ample strength. This is essentially a single-purpose machine. It occupies a floor space of 6 feet 2 inches by 10 feet, and weighs 4200 pounds.

**Horizontal Keyseater:** Chattanooga Machinery Co., Chattanooga, Tenn. A machine designed for keyseating holes of unusual length, and especially for cutting the keyseats in long rolls. The machine consists of three essential parts, i. e., a jig for holding and centering the work, a bar and cutting tool, and mechanical means for reciprocating the bar.

**Elevating Truck:** Columbus Lift Truck Co., Columbus, Ohio. In this truck the elevating of the freight platform from the floor is accomplished by means of four levers, two of which are located at each end of the truck. Each lever is pivoted to the truck frame, and the ends of the levers are raised by cams which are rotated by operating the lever at the front of the truck.

**Hose Coupling:** National Hose Coupling Co., Peoples Gas Bldg., Chicago, Ill. This coupling is adapted for use on hose lines carrying compressed air, steam or water, and may be attached without the use of clamps, straps or special fastening tools. The sockets are made of malleable iron, and all other parts of steel, so that a high degree of strength and durability is assured.

**Multiple Punching Machine:** Bertsch & Co., Cambridge City, Ind. The special features of this machine consist of the use of a cored section frame, and of the employment of a special type of coupling for the gagged punches. The head of the machine contains twenty punching units, each of which is provided with a gag, so that any number of punches from one to twenty can be used at a time.

**Screw Press:** Charles Stecher Co., Chicago, Ill. A press designed especially for testing all kinds of cutting, stamping, embossing and forming dies. The slide is fitted with a regular press cap instead of a set-screw, and has long guides and liberal bearing surfaces. The press will hold tools with shanks up to 3 inches in diameter. As its name implies, the slide of this press is operated by a screw.

**Friction Clutch Pulley:** L. W. Carroll Mfg. Co., Batavia, Ohio. This clutch pulley is of simple and compact construction, and is equipped with a friction disk of large diameter, which affords a firm grip when the clutch is engaged. The sleeve which carries the friction disk is threaded on the end to receive the clutch dog and fingers, thus providing means for making accurate adjustments.

**Shrapnel Shell Spraying Machine:** Spray Engineering Co., Boston, Mass. A machine developed for use in spraying the inside of shrapnel shells or any other work where the surface on which the protective coating is to be applied is relatively inaccessible. The shells are sprayed with asphaltum paint or other non-corrosive material, and the machine applies a uniform coating to the shell without wasting any of the paint.

**Cutting-off Machine:** Brightman Mfg. Co., Columbus, Ohio. A special type of machine developed for use in cutting off all sizes of round vanadium and special alloy steel bars and shafting. Means are provided for backing out the tools by power after the cut has been completed; and the machine is capable of cutting short pieces from both ends of a long bar, or of cutting the work up into disks. This cutting-off machine weighs approximately 11,000 pounds.

**Surface Gage:** W. D. Forbes, New London, Conn. A surface gage of simple construction which can be made to sell

at a low price. Rapid vertical adjustment is obtained by sliding the supporting arm on the column, and a thumb-screw permits the arm to be shifted to any desired position. A coarse vertical adjustment may be obtained by tilting the supporting arm, and micrometer adjustment of the needle is secured by operating a knurled thumb-nut.

**Cylindrical Grinder:** Queen City Machine Tool Co., Cincinnati, Ohio. The design of this grinder follows lines similar to those of the machine which this company has been manufacturing. The chief point of difference lies in the fact that many parts are made heavier. The present machine was primarily designed for performing grinding operations on explosive shells, and it is also adapted for any plain cylindrical, taper or formed grinding which comes within its capacity.

**Drilling Machine:** Charles Stecher Co., Chicago, Ill. A high-speed bench drilling machine, which can either be provided with a bench or set up on the work bench, according to the requirements of individual users. The head of the drill is stationary, but provided with means of compensation for wear in the spindle sleeve. The spindle is counterbalanced and provided with a drift hole of the usual form; it is bored No. 1 Morse taper and runs in bronze bushed bearings.

**Belt Shifter:** Dearborn Steel & Iron Co., Chicago, Ill. A belt shifter which eliminates the use of a pole when changing the belt from one step of the cone pulley to any other desired position. This shifter can be readily attached to a machine, and provides for shifting the belt by means of two convenient handles. The provision which is made for shifting the belt by a purely mechanical means, does away with the danger of accidents which sometimes occur in the shifting of belts with a pole.

**Portable Electric Drill:** Standard Electric Tool Co., Cincinnati, Ohio. A portable drill in which the motor is suspended from a trolley track, making it easy to move the tool from one piece of work to another. The motor is for use in connection with 110-volt direct current, but special motors may be furnished for connection with any voltage up to 250. Ball bearings are employed throughout the machine, and these bearings are packed with grease and carried in dust-proof chambers.

**Boring and Threading Tools:** Rigid Tool Holder Co., 149 Carroll St., S. E., Washington, D. C. This concern is manufacturing three types of tool-holders and a boring-bar, which have been designed with the view of securing maximum rigidity. The boring-bar is held in a yoke which can be raised or lowered in order to bring the point of the cutter into any desired position. Of the three tool-holders, one is of the adjustable type, one is a single reversible holder, and one is a "gooseneck" holder for threading tools.

**Spur Gear Planing Machine:** George A. Schipper, Aurora, Ind. One of the noteworthy features of the design of this machine is that a roughing and a finishing cutter are carried in the same slide in such a way that the tools work alternately. The cutters are formed so that they may be ground all over after hardening. The work spindle is mounted in such a way that the maximum rigidity is obtained; and there is said to be no tendency for the tool-slide to chatter when the machine is working at high speed. This machine is particularly adapted for manufacturing, and is said to possess a high capacity for producing accurately finished spur gears.

**Thread Milling Machine:** A. R. Williams Machinery Co., Ltd., 64-66 Front St., W., Toronto, Canada. This machine is built by the Holden-Morgan Co., Ltd., of Toronto; and the A. R. Williams Machinery Co. has the sales agency. The machine is designed for threading high explosive shells, and will produce a perfect thread in the base of a shell in approximately 2½ minutes. One machine is required for recessing and threading the base of the shell and one machine for threading the nose of the shell. The shell is placed inside of a revolving spindle, where it is automatically centered; and the machine is fitted with an automatic stop which comes into action when the thread has been completed. The cutter used on this machine is of such a shape that it can be sharpened without changing the form; the cutter is designed to mill the top of the thread as well as the sides. One operator can run several machines, and it is claimed that their operation is so reliable that all risk of having shells rejected on account of stripped threads is overcome.

* * *

The cost of a moderate sized heat-treating department, including a coal fired furnace, five to seven barrels of hardening oil, one barrel of drawing oil, tanks for holding the oil, and a pyrometer, varies from $500 to $600. This equipment is sufficient for ordinary hardening. When casehardening is required, casehardening boxes and carbonizing compound must be added to the equipment mentioned, and a second furnace is desirable. Hence, the equipment for casehardening costs more than that required for regular hardening.

## CAMERA FOR READING METERS

To provide a reliable method of reading gas, electric, and water meters, in which the possibility of error is eliminated and a permanent record is available in case of dispute, the Eastman Kodak Co., Rochester, N. Y., has developed a special camera which is known as the "factograf". Another application is in reading the "peak" on demand meters before they are reset for the next month, where the application of the camera is particularly valuable in that it records with photographic accuracy. The meter-reader can not only work more accurately with a "factograf" camera than he could by the old method, but he can also work more rapidly; and when his record is turned in at the office there can be no doubt as to its reliability. The reading of a meter is taken by placing the front of the camera against the meter dial and pressing down on the exposure lever. This automatically turns on the light, opens and closes the shutter, and turns off the light. After each exposure, the shutter is automatically locked and remains locked until the film for the next exposure has been wound into place. The shutter is then automatically returned to the "set" position. In this way, the possibility of a double exposure is eliminated; and there can be no blanks, because the film cannot be wound off until the exposure has been made. These results are obtained by having the winding reel and shutter interlocked.

Fig. 1. Eastman "Factograf" for Use in recording Readings of Meters

The camera is shown in Fig. 1, which gives a good idea of its general appearance. It measures 4¼ by 5¾ by 12¼ inches and is made from a selected grade of mahogany which is specially treated to withstand the action of moisture. The camera is equipped with an anastigmat lens working at F 6.3 and a simple automatic shutter. Exposures can be made varying from 1/5 to ½ second, according to the light conditions. The necessary light for the exposure is furnished from two four-cell dry batteries which are stored at each side of the camera and supply current to four 3.8-volt miniature tungsten lamps. The exposure is recorded upon a special sensitive emulsion on a paper support, the size of the picture being 1½ by 2⅛ inches. The film is supplied in the familiar cartridge form and the camera may be loaded in daylight. Storage space for two extra rolls of films is provided in the dark chamber of the camera so that the capacity is for 225 readings. There is a small drawer in front of the camera carrying six extra lamps, and the camera is equipped with a reinforced handle by which it is carried; by pressing a small button located below the exposure lever, the lights may be turned on to convert the camera

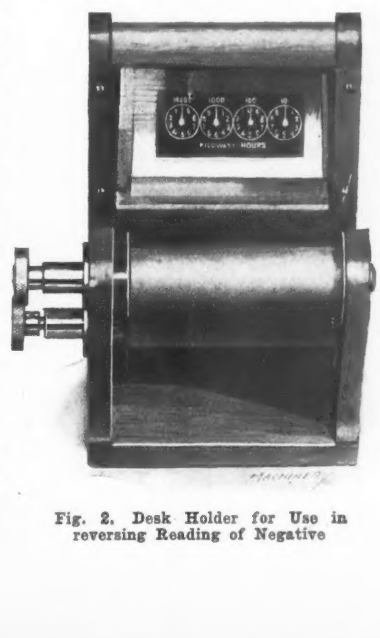


Fig. 2. Desk Holder for Use in reversing Reading of Negative

into the equivalent of an electric torch for locating meters or finding one's way through dark cellars.

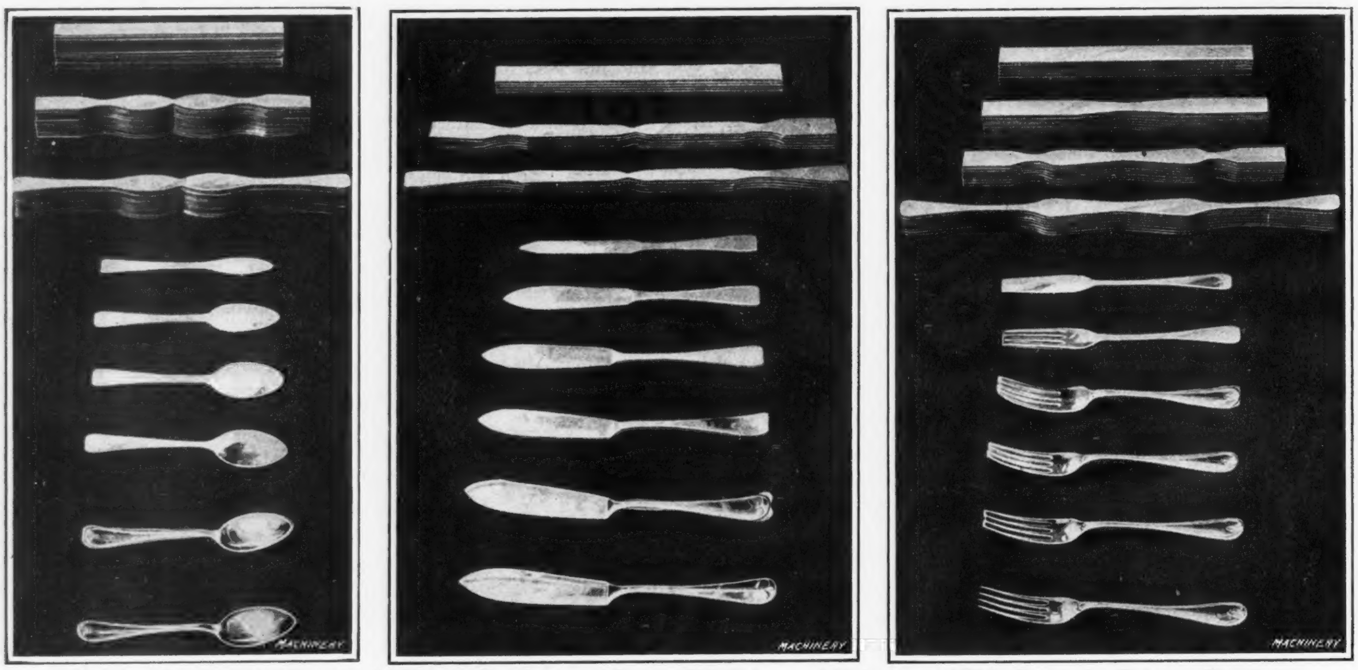
A desk-holder is provided with the camera, equipped with a mirror for reversing the readings which are negative. The camera may be provided with a card showing the meter reader's name, route number, and the date, which may be placed against the front of the camera and photographed to identify the record. There appear to be a variety of applications for the "factograf" camera in factory use. The first actual application has been made in electric central-stations for photographing the meter readings; and there is the same application in reading the meters in the works of gas companies and water pumping stations. In machine shops, the camera could be used to advantage in recording the readings of gas, water and electric meters.

* * *

## THE WILZIN PROCESS FOR FLAT-WARE MANUFACTURE

For use in the manufacture of all kinds of flat-ware from the different metals used in this industry, Arthur Wilzin, managing director of the E. W. Bliss Co.'s branch in Paris, has developed an improved process which is described in the following article. The principal merits of this process are that not more than 10 per cent of the material is wasted in the form of scrap, that imperfections in the material are remedied by the process so that very few defective parts are produced, and that unskilled labor can be utilized. It will thus be evident that this process provides for making a material reduction in the cost of manufacture. The first patents were issued in France in 1909, and since that time a series of special presses, tools and dies has been developed in the factory of the E. W. Bliss Co., St. Ouen, France, under the personal direction of Mr. Wilzin. Foreign patents have been obtained and the Wilzin Process Corporation, 60 Wall St., New York City, has recently been organized for the purpose of licensing American flat-ware manufacturers to operate under the Wilzin patents. That this process has been developed to a point where it is entirely ready for practical application is attested to by the fact that a number of the leading European manufacturers are now using it. The process is applicable in the manufacture of all styles and patterns of flat-ware, regardless of the base metal that is used.

The successive steps involved in this process and the manner in which they are conducted are well shown by the accompanying illustrations. Figs. 1 to 3 show different classes of flat-ware in the successive steps through which the work passes before reaching completion. Figs. 4 and 5 show the Wilzin quadruple expansion profiling press, and Fig. 6 shows the profiling dies used in this machine. Fig. 7 shows the die used for cutting up the blanks and for preparing the ends for subsequent treatment, and Fig. 8 shows the tools used for performing the "bowl spreading" operation on spoons. These tools will be referred to in detail in subsequent paragraphs.



Figs. 1 to 3. Successive Steps involved in the Manufacture of Spoons, Fish Knives, and Forks by the Wilzin Process for Flat-ware Manufacture

### Strip Cutting and "Package" Assembling

The material used is ribbon stock, and the first step consists of cutting this material up into strips of suitable length. For this purpose, a standard form of power press is employed which is equipped with a cutting-off attachment that provides for the production of all sizes of strips. In most cases, the strips contain sufficient metal to produce two blanks, but in the case of very small spoons, the strips are made large enough to produce four blanks. The rate of production is from 50 to 60 strips per minute, one strip being cut off at each operation. The strips are next assembled into packages as shown at the top of each illustration, in Figs. 1 to 3, each package containing from 8 to 18 strips, according to the gage of metal being used. Each package contains sufficient metal to produce from 16 to 48 blanks, *i. e.*, 8 to 18 two-blank strips or 12 four-blank strips.

### The Profiling Operation

The packages of strips are next subjected to a profiling operation in a Wilzin quadruple expansion press; one of these presses is shown in Fig. 4, and Fig. 5 shows a close view of the working mechanism with the die-holder drawn forward to the position which it occupies while changing the tools. The press applies a pressure of from 150 to 250 tons on all sides of the material, and two or three profiling operations are required, according to the character of the work. It will be seen from Fig. 5 that two sets of dies are employed in the profiling press. At each side of the metal there is a flat die which serves to restrain the material from flowing sidewise, and the same flat dies can be used for all classes of work. The profiling dies are shown in place in Fig. 5, and a detailed view of different types of these dies is presented in Fig. 6. The profiling dies act on the edges of the strips and cause the metal to flow longitudinally without change of thickness, the condition of the work after successive profiling operations being shown in Figs. 1 to 3 for different examples of flat-ware.

It will be evident from the illustrations that the profiling dies are of very simple construction so that they are inexpensive to make, and one set of tools has been found to have a capacity for producing over 1,000,000 pieces. The time required for changing and setting up the profiling tools is less than two minutes, their correct longitudinal and lateral positions being determined without having to make careful measurements. End blocks center the punches longitudinally and

the lateral position is determined by side pressure blocks, so that the only adjustments required are for height and back gage. The Wilzin quadruple expansion profiling press was especially designed for this work, and it embodies well-known features of E. W. Bliss power presses, which insure rapid and reliable operation. Each press is equipped with a pressure indicator which records the pressure for each stroke of the press and enables the operator to set the plunger adjustment without danger of injury to the dies and without resorting to any cut-and-try methods. It was mentioned in the introductory paragraph that one of the features of this process consists of overcoming imperfections in the material, so that no defective pieces are produced. This is due to the high pressure applied to the surface of the metal from all four sides, which results in improving its structural qualities, so that slight flaws are closed up. This feature stands out in marked contrast to the results obtained by other methods, where the working of the metal serves to accentuate any defects in the material.

The number of profiling operations that are necessary differs with the character of the work. For spoons of all sizes two operations are required, with one change of profiling dies. For forks of all sizes, three profiling operations are required with two changes of dies. Other articles need two or three profiling operations, according to the size and shape of the work. All the profiling operations are performed on the cold metal with the exception of blanks for the larger sizes of tablespoons, in which case the work requires one annealing treatment. The capacity of the profiling press is for seven to ten operations per minute and 16 to 48 blanks are produced at each operation.

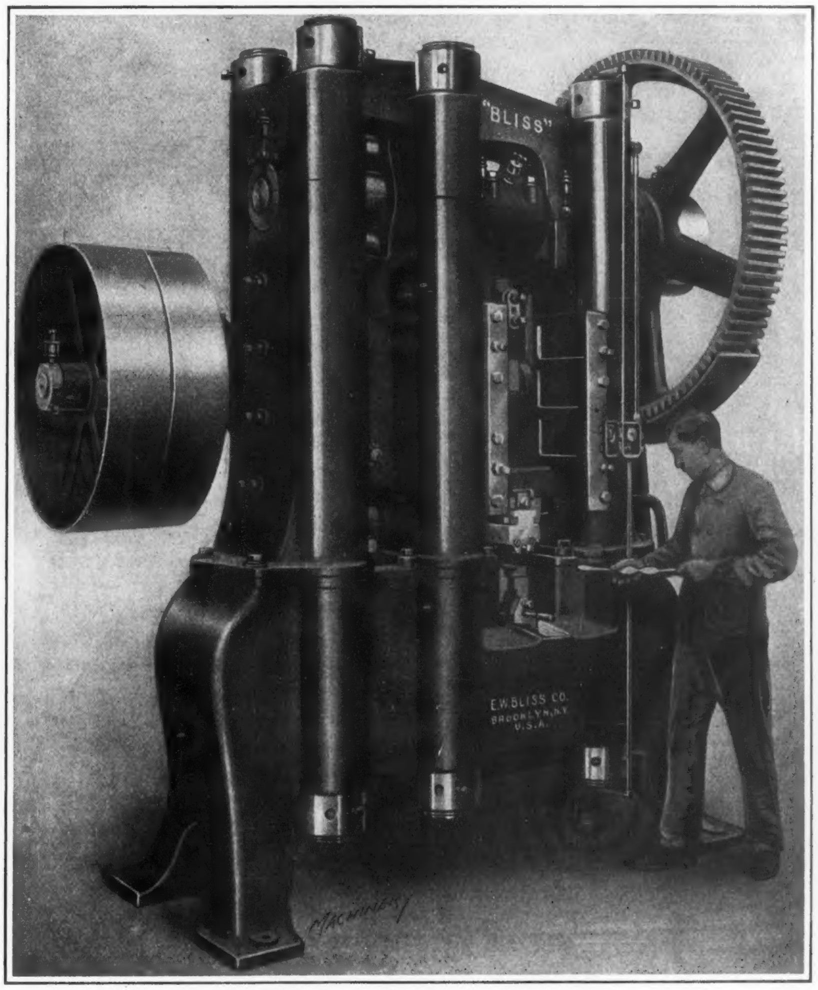


Fig. 4. Wilzin Quadruple Expansion Profiling Press

### Parting the Blanks

The strips of metal, as they leave the profiling press, are next cut into individual blanks in a press fitted with a parting tool. For spoons, the entire package of strips is parted in one or two operations, according to the size of the spoons, one operation being employed for each package of two-blank strips, and two operations for each package of four-blank strips. Twenty operations are performed per minute; sixteen to thirty-six blanks are cut off per operation on the two-blank packages, and twenty-four blanks per operation from the four-blank packages. For forks of all sizes, the strips are parted separately with the combination parting and end-preparation die shown in Fig. 7. Twenty operations are performed per minute and two blanks are produced at each operation.

### End Preparation

The individual blanks are next submitted to the action of end-preparation dies, one of which is shown in Fig. 8; these are fitted to presses of suitable capacity according to the size of the blanks. This operation completes the shaping and grading of the blank with the exception of the stem. The end-preparation dies shown in Fig. 8 are for use on spoon blanks; the lower tool is a hardened tungsten steel block with its working surfaces absolutely straight, so that it is easily ground. This tool may be employed for all shapes and sizes of bowls, the contour of which is determined by the edge confining pieces that are simple to make and easy to place in the gaging pieces, which are standard for all sizes of spoons. The exact grading of the bowl is secured by the action of surface punches. It will be understood, of course, that by convexing their surfaces, the bowls are graded to secure the desired distribution of the metal; *i. e.*, thin in the center and increasing gradually in thickness toward the edge. By hollowing out the punches at the base, it is an easy matter to accumulate any amount of metal required for the relief of flowered or figured designs. For spoons and similar articles, two operations are required with one change of dies, while for forks only one operation is required. For spoons, the rate of production is twenty operations per minute and one blank is produced at each operation; the rate of production is the same for forks.

### Upsetting, Flat Polishing, Embossing, Trimming and Final Polishing

The stems of all blanks are next submitted to the action of a simple stem-upsetting die which is fitted in a flywheel press of standard design. The rate of production is twenty operations per minute, and one blank is produced at each operation. After this work has been completed, the flat blanks are next polished on a cotton buff. This operation is generally done by hand, and the output depends largely upon the experience of the operator. In some cases, an automatic polishing machine is used, which greatly increases the rate of production. The blanks produced by the Wilzin process have an even surface, due to the high pressure to which the metal is subjected and, as a result, very little polishing is required. The blanks are then ready for the final stamping and embossing operations for which one-piece embossing dies are used in E. W. Bliss embossing presses especially designed for use in the manufacture of flat-ware. The rate of production is from eight to twelve operations per minute, depending upon the size of the pieces, and one piece is produced for each operation. The embossed pieces have a slight "flash" around the entire edge, which is removed by a suitable size of press fitted with a simple trimming die. The amount of scrap metal produced in this way never exceeds 10 per cent. The rate of production is twenty operations per minute, one piece being produced at each operation. The final polishing operation consists of smoothing and rounding the edges of the work after the flash has been removed, and of giving the surfaces

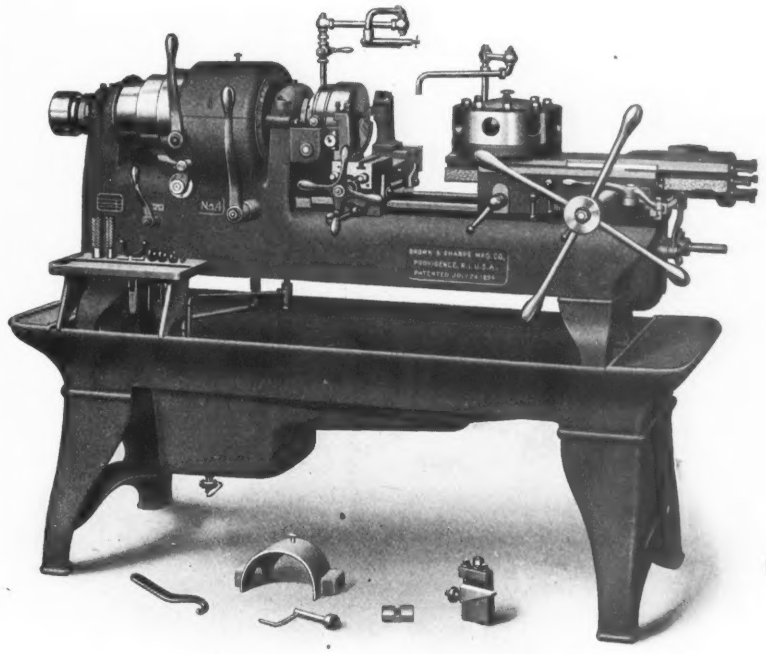
READ PAGE 79

# A Good Machine for Making Parts From Bar Stock in Small Lots

In many shops there is a good deal of work, such as screws, studs, bolts, nuts, small machine parts, etc., made from bar stock, that comes in lots too small to make it worth while setting up on an automatic screw machine. Some of the jobs, unless handled on an efficient machine, would take longer to set up than to finish. To do this work economically a machine is necessary that can be quickly set up and rapidly operated. Another point—short jobs will not warrant the expensive special tooling that is often required when a job is long enough for an automatic machine, so it is necessary to provide a machine that will handle the work with simple tool equipment. Meeting all these requirements the

## B. & S. No. 4 Wire Feed Screw Machine

effectively supplements a group of automatic screw machines and makes a valuable addition to the equipment in the shop for handling work that comes mainly in small lots.



Our Automatic Chuck, an exclusive Brown & Sharpe feature, saves much time in setting up. It operates as quickly as a spring collet, by a single lever, but has the added advantage of being self-contained and universal in range. It is adjustable for any size of stock within its capacity by simply turning with a wrench like a universal chuck. There is no hunting around for loose parts every time a job is set up. A few turns of a wrench and the chuck is set. Any standard shape of stock can be handled without special jaws.

The Automatic Roller Feed, another important feature, is operated in conjunction with the chuck by the same lever. Like the Automatic Chuck it is universal in range and is very quickly adjusted. It feeds to any length without adjustment, and being located directly behind the chuck, will feed practically to the end of the bar.

The turret is indexed each time it is returned and when brought into working position it is automatically locked and clamped, thus insuring proper alignment at all times. Eight changes in feed for the turret slide are available for each spindle speed. This feed is driven direct from the spindle by sprocket and chain. Many other features are outlined in detail in our descriptive literature. Send for it.

# Providence, Rhode Island, U. S. A.

**CANADIAN:** The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John.

**FOREIGN:** Buck a Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow, G. F. Kretschmer & Co., Frankfurt a.M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

of the work the final polish; this is done with a cotton buff, without requiring the use of an emery belt. The labor involved in the performance of the latter operation is materially reduced owing to the fact that a high burnish and luster is imparted to the work by the embossing dies.

### Advantages of the Wilzin Process

The advantages of the Wilzin process for the manufacture of flat-ware may be briefly summarized as follows: (1) It eliminates the cross and grade rolling operations. (2) It reduces the applied labor costs of manufacturing the flat graded blanks. This saving is due to the low labor cost of the press operations, to the possibility of profiling the blanks in packages containing from 16 to 48 blanks, and to a reduction of the number of annealing treatments that are necessary or the complete elimination of annealing. (3) Absolutely uniform blanks are produced. (4) The applied labor costs of grinding, polishing and buffing are materially reduced. (5) The pressure applied to the metal in the profiling operation improves its structural qualities; and the high pressure applied in subsequent operations produces an extremely hard burnished surface. (6) The combination of the polished blank, the highly burnished embossing die, and the slow elastic squeeze of the embossing press, transfers the high luster of the embossing die to the surface of the work. (7) The amount of material lost in the form of scrap does not exceed 10 per cent. (8) The cost of the tools required is relatively small, as these are of simple design.

The Wilzin Process Corporation has acquired the exclusive rights to this process of flat-ware manufacture in the United

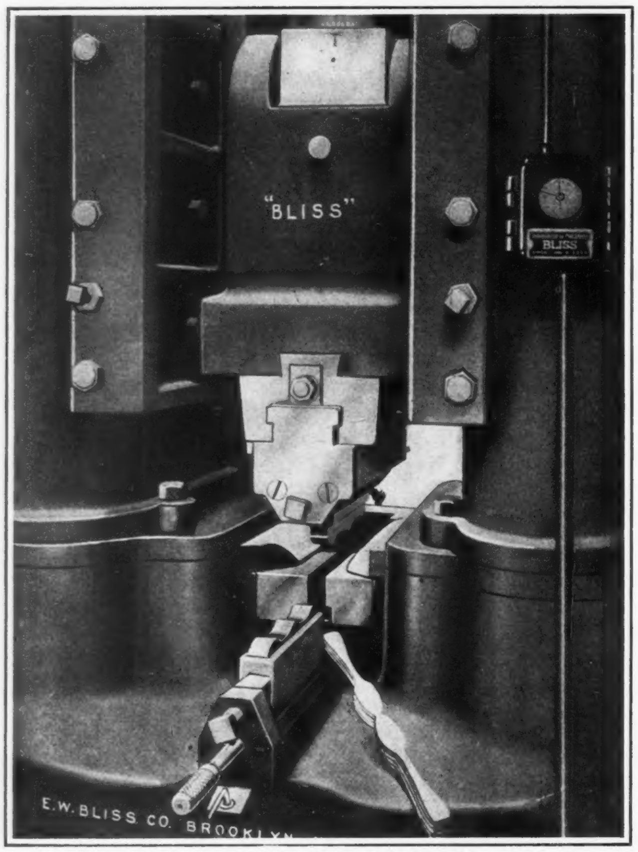



Fig. 5. Close View of Profiling Tools with Die-holder drawn Forward

States, and is prepared to grant licenses to flat-ware manufacturers to operate under its patents. The plan is to lease the Wilzin quadruple expansion profiling presses and to sell

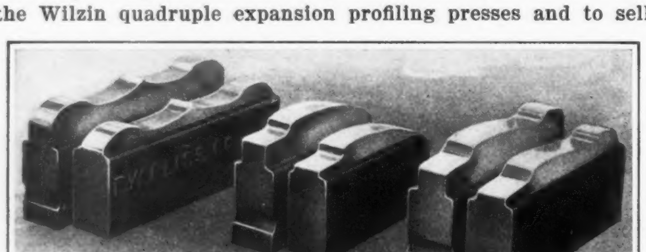


Fig. 6. Different Types of Profiling Tools used in the Wilzin Process

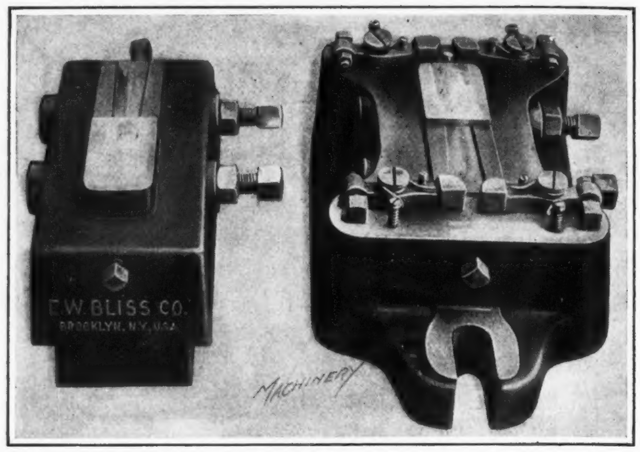



Fig. 7. Combination Parting and End-preparation Tools for Use on Forks

the necessary equipment of the E. W. Bliss power presses, tools, and dies which are required. The Wilzin Process Corporation will act as selling agent in the United States

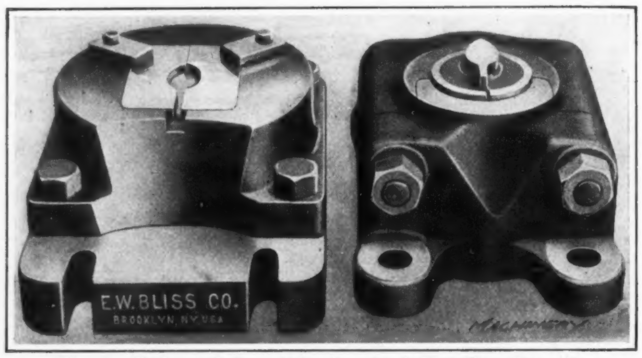



Fig. 8. Tools used for performing Bowl Spreading Operation

for all equipments required in using the Wilzin process, and the equipment will be built by the E. W. Bliss Co., Brooklyn, N. Y. A service department will be maintained for the regular inspection of the quadruple expansion profiling presses, and the services of the engineers of the Wilzin Process Corporation will be available in making estimates of the manufacturing cost of any piece or series of pieces by the Wilzin process, and in giving expert advice to licensees.

* * *

## PERSONALS

J. O. Hobby, Jr., was appointed treasurer of the American Locomotive Co., 30 Church St., New York City, at the meeting of the board of directors held August 11.

Albert J. Ott, formerly with the Landis Tool Co., is now Western representative for the Modern Tool Co., Erie, Pa., makers of self-contained grinding machines and precision tools, with offices at 32 North Clinton St., Chicago, Ill.

W. S. Burgess has disposed of his interest in the Stoddard-Burgess Co., 426 S. Clinton St., Chicago, Ill., to E. B. Stoddard, who will continue the business. Mr. Burgess has been salesman for eight years with the Imperial-Brass Mfg. Co., and is well acquainted with brass foundry and machine-shop practice.

Fred. H. Moody, mechanical editor of the *Canadian Railway and Marine World*, has joined the Canadian expeditionary force and gone to the front. He has been promoted to the rank of captain and is second in command of his company. Mr. Moody was formerly associate editor of MACHINERY.

J. F. Richman, formerly factory production manager of the Cole Motor Car Co., Indianapolis, Ind., has been promoted to the position of factory manager of the standardized plant. Mr. Richman has been with the Cole Motor Car Co. for about three years. His practical knowledge of the gas engine and motor car has been an important factor in perfecting the Cole eight-cylinder car.

O. P. Hand has been appointed director of publicity of the Burd High Compression Ring Co., Rockford, Ill., manufacturer of Burd high compression piston rings. Mr. Hand, who will assume his new duties at once, comes to Rockford after fourteen years' experience as advertising manager for the Minneapolis Iron Store Co. and an extended connection as editor of a prominent trade journal.

Howard E. Coffin and Andrew L. Riker, past-presidents of the Society of Automobile Engineers, have been selected to serve on the civilian advisory board, which will be organized by the United States Navy Department in September. Mr.

Riker was the first president of the Society of Automobile Engineers, serving in this capacity three terms. Mr. Coffin became its president in 1910, and was the prime originator of the movement which has resulted in the standardization of component materials and parts of automobiles.

* * *

## OBITUARY

John Parker, for over twenty years in charge of the milling machine designing for the Brown & Sharpe Mfg. Co., died July 23, following a brief illness, aged fifty-one years. Mr. Parker's whole life was practically devoted to the mechanical field, and many successful developments in the design and construction of machine tools are largely due to his efforts. His first employment, covering four years, was in the drafting department of the Corliss Steam Engine Co., Providence, R. I. Leaving this company, he went to the Brown & Sharpe Mfg. Co. in 1891; and in 1893 took active charge of the milling machine designing. In connection with this position he also held that of assistant chief draftsman, from 1895 to 1902, when the volume of work on milling machines at this time became so great that it required almost exclusive attention. As assistant chief draftsman he developed good executive ability in putting work through correctly and efficiently, and this stood him in well in after years. During his service Mr. Parker gained a wide and valuable experience, for he was called upon at different times to assist in the designing of machines for almost every line of work carried on by the company. Many patents were granted him, chiefly in connection with his work on milling machines. Few men have devoted more careful study and given greater effort to develop these machines than Mr. Parker. Largely due to his credit stands the modern constant-speed drive machine with speeds and feeds independent. He was a member of the American Society of Mechanical Engineers, before which body he presented and discussed several papers. He also contributed some important articles to the technical press on milling machines and other subjects. Mr. Parker's quiet disposition won him many friends, and his firm, yet kind and liberal personality had a strong influence on the men who worked under his direction. His methods were such as tended to develop the full ability of men, by placing on them as great responsibility as possible; at the same time he always stood ready to give them the benefit of his wide experience. His clear logical manner of solving problems and his patience and willingness to explain at length those points which often troubled his men will long be remembered. In his dealing with the men in both the drafting department and the shop he seldom made a ruling or gave an order that he could not consistently follow himself. Mr. Parker had a remarkable capacity for details, and his ability to answer correctly and off-hand many questions connected with his work was often a great help to those working with him. He is survived by his widow, a son, a daughter, five sisters and two brothers.

## COMING EVENTS

**September 7-10.**—Twenty-third annual convention of the Traveling Engineers' Association, Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, East Buffalo, N. Y.

**September 9-11.**—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

**September 25-October 2.**—Annual exhibit of the Foundry & Machine Exhibition Co., Atlantic City, N. J., in conjunction with the American Foundrymen's Association convention. Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

**September 27-October 1.**—Annual convention of the American Foundrymen's Association, Atlantic City, N. J.

## SOCIETIES, SCHOOLS AND COLLEGES

**Swedish Engineering Convention in the United States.** Program of the convention to be held at the LaSalle Hotel, Chicago, September 9, 10 and 11, 1915, containing useful information and outlining the program, which consists of two engineering sessions with four papers, as well as visits to a number of industrial works in and around Chicago, including the Gary Steel Works, the Pullman Co. Works, the Fiske St. Power Station, the Western Electric Co., and the Union Stock Yards. C. G. Axell, Room 619, City Hall Square Bldg., Chicago, Ill., is the secretary of the convention. A party of engineers from the East will leave New York City September 6, stopping over at Schenectady and Niagara Falls, and visiting industrial plants at these points.

## NEW BOOKS AND PAMPHLETS

**An Investigation of Iowa Fire-Clays.** By Milton F. Beecher. 115 pages, 6 by 9 inches. Bulletin No. 40, published by the Engineering Experiment Station, Iowa Stage College of Agriculture and Mechanic Arts, Ames, Iowa.

**Wind Stresses in the Steel Frames of Office Buildings.** By W. M. Wilson and G. A. Maney. 88 pages, 6 by 9 inches. 32 charts and tables. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill.

This is Bulletin No. 80 of the Engineering Experiment Station of the University of Illinois, and contains a description of an accurate method used for determining wind stresses. Copies of the bulletin may be obtained free of charge by application to C. R. Richards, acting director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

**Directory of Piston Ring Sizes.** Applicable to automobiles, motorcycles, cycle cars, trucks, tractors and engines. Published by Burd High Compression Ring Co., Rockford, Ill. Price, 50 cents.

This little book gives information intended for the owner and repair man of automobiles, motorcycles, etc., as well as for the dealer. It specifies the number of rings per piston and the number of cylinders, as well as the sizes of the rings of a great number of automobiles and motorcycles, trucks, etc. These piston rings are supplied by the Burd High Compression Ring Co. The book contains instructions for fitting rings into the piston groove, fitting cylinders, etc.

**Combustion and Smokeless Furnace.** By Joseph W. Hays. 118 pages, 6 by 9 inches. Illustrated. Published by Combustion Appliances Co., Rogers Park, Chicago, Ill. Price, $2.

The importance of smokeless combustion is appreciated by all who have given any attention to elimination of smoke, and the elimination of smoke in great cities means great saving of property spoiled by soot, the general promotion of personal comfort, etc. The damage caused by smoking chimneys in Chicago alone is estimated by one writer to be $40,000,000 annually. This is the second edition of the book that was first published in 1906. It has been revised and brought up to date, and treats of heat and combustion, combustion and the boiler furnace, combustion and the steam boiler, the chimney evil, smokeless furnaces in general, mechanical stokers and hand-fired furnaces.

**Mathematics for Machinists.** By R. W. Burnham. 229 pages, 5 by 7 inches. 175 illustrations. Published by John Wiley & Sons, New York City. Price, $1.25.

This is one of the volumes in the Wiley Technical Series for Vocational and Industrial Schools, and has been prepared especially for the use of trade schools and for home study. Beginning with fractions, the book aims to give, in an elementary form, an explanation of the calculations most frequently met with in machine shop work. The treatment has been made as simple as possible. An attempt has been made to show the steps in a calculation in logical order, and it is believed that the material presented in this book and the method of treatment will be found well adapted for trade school education. The book contains chapters on common fractions, decimal fractions, percentage, blueprints, measurements, powers of numbers, square root, lathe work, threads and thread cutting, simple machines, work, power, ratio, gear calculations, milling machine indexing, volume and weight, shop trigonometry, and business organization.

**Electrical Measurements and Meter Testing.** By David Penn Moreton. 328 pages, 4 by 6½ inches. 191 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, bound in cloth, $1.

This work was prepared to meet the needs of practical men desiring to obtain a working knowledge of electricity as applied to electrical measurements and meter testing, but who are unable to take a complete course in electrical engineering. The author is assistant professor of mechanical engineering, Armour Institute of Technology, Chicago, and has prepared the work in plain language to meet the needs of this class. It treats of the direct-current circuit, magnetism, electromagnetism and electromagnetic induction, inductance and its measurement, capacity and its measurement, alternating-current circuit, calculation and measurement of resistance, measurement of current and pressure, construction and operation of wattmeters, construction and operation of watt-hour meters, methods of distributing energy, calibration of galvanometers, ammeters, voltmeters and wattmeters, testing watt-hour meters and special indicating and recording instruments. The work is one that should be found generally satisfactory to those who wish to get a working knowledge of electrical measurements in the simplest terms.

**Modern Plumbing Illustrated.** By R. M. Starbuck. 407 pages, 7 by 10½ inches. 58 full-page illustrations. Published by Norman W. Henley & Son, New York City. Price, $4.

This is a comprehensive and thoroughly practical work on the modern and most approved methods of plumbing construction, intended especially for plumbers, architects and builders, as well as for trade classes in plumbing. It should be useful also for property owners, boards of health, and plumbing inspectors. Great changes have taken place during the last decade or two in relation to plumbing, and in bringing out the third edition of this book the required revisions to bring the work up to date have, therefore, been made. The work is designed to cover the entire field of plumbing as far as possible, and the subjects considered cover a variety of lines of work, including fixture work in detail, the construction of the drainage and vent systems in detail, and complete plumbing systems of buildings of various kinds. While the work is intended to cover subjects pertaining to drainage alone, the subject of water supply is in many instances closely associated with the drainage problem, and the author has therefore found it advisable, in many instances, to take up the subject of water supply. It would be impossible to give an idea of the contents of the book in a brief review of this kind, as each of the fifty-eight full-page illustrations is accompanied by a chapter of descriptive matter, every one of which deals with some particular phase of plumbing. The work gives evidence of the fact that the author has endeavored to convey the information in as complete and concise a manner as possible, making it at the same time entirely clear and comprehensible. Unnecessary and obsolete matter has been excluded in the new edition, and as far as possible the work has been kept up to date.

## NEW CATALOGUES AND CIRCULARS

**Moore & White Co.**, Philadelphia, Pa. Catalogue of friction clutches and variable speed changes.

**Reed & Prince Mfg. Co.**, Worcester, Mass. Catalogue of taps, micrometer calipers and screw gages.

**Automatic Drill Chuck Corporation**, Detroit, Mich. Circular of "Quictite" full automatic chucks for drilling machines.

**Rub-on Mfg. Co., Inc.**, Brayton St., Buffalo, N. Y. Circular on a combination jack, auto-turn jack, and towing truck for garage use and for towing in crippled cars.

**Templeton, Kenly & Co., Ltd.**, 1020 S. Central Ave., Chicago, Ill. Bulletin 115 describing "Simplex" jacks for steam and electric railroads, automobiles, and general purposes.

**D & W Fuse Co.**, Providence, R. I. Booklet of D & W enclosed fuses, illustrating and describing construction, and listing fuses from 30 amperes to 1000 amperes capacity.

**Joseph Dixon Crucible Co.**, Jersey City, N. J. Booklet about graphite brushes for commutators of electric motors and generators. The booklet describes how the characteristic lubricating qualities of graphite reduce commutator troubles to a minimum.

**National Machinery Co.**, Tiffin, Ohio. Folder relating to "Tapping Nuts 'Square' on the National Automatic (Bent Tap) Nut Tapper". The folder contains illustrations showing clearly the action of the machine in tapping nuts.

**Canton Foundry & Machine Co.**, Canton, Ohio. Catalogue of alligator shears of the stationary and portable types and the low-knife and high-knife types. The heaviest shear has a capacity of four-inch square bars in soft machinery steel or iron.

**Offset Tool Co.**, Bridgeport, Conn. Circular of an offset drilling machine attachment for drilling, reaming, counterboring, countersinking, hollow-milling, etc., under ledges and in other places inaccessible to the ordinary drilling machine spindle.

**Ellsworth Haring**, 114-118 Liberty St., New York City. Catalogue of resistance metals, ignition metal, spark-plug wire, nickel sheets and wire, nickel alloys, music wire, etc. The catalogue contains tables giving electrical properties of the resistance metals listed.

**Stow Mfg. Co.**, Binghamton, N. Y. Bulletin 400, illustrating and describing some of the portable tools made by the company, including portable drills, grinders, screw-drivers, etc., both belt- and motor-driven, as well as flexible shaft center grinders, drills, emery grinders, etc.

**Foote Bros. Gear & Machine Co.**, 210-220 N. Carpenter St., Chicago, Ill. Catalogue illustrating and describing the Foote-Strite transmission, adaptable to practically any type of tractor. This is a new departure in the gear line of the company, and is just being placed on the market.

**New Departure Mfg. Co.**, Bristol, Conn. Bulletin 39, "Ball Bearings in Manual Training School Lathe Work"; 40, "Change-speed Gearing for Heavy-duty Metal-working Machinery"; 41, "Miscellaneous Two-bearing Mountings"; 42, "Ball-bearing Spindle for Sensitive Drill Press".

**Shepard Electric Crane & Hoist Co.**, Montour Falls, N. Y. Bulletin 506, illustrating a variety of electric hoist types, all characterized by provision for dirt exclusion, bath lubrication and permanent alignment. The hoists illustrated are built in capacities ranging from 1 to 12½ tons.

**Crucible Steel Co. of America**, Pittsburg, Pa. Catalogue of "Rex" high-speed steel, giving the sizes in which this quality of steel is made in rounds, squares, octagons and flats. The catalogue also contains suggestions for forging, grinding hardening and annealing "Rex" high-speed steel.

**Standard Pressed Steel Co.**, Philadelphia, Pa. Booklet entitled "Data on Safety and Efficiency in Power Transmitting Appliances, Catalogue No. 2". This booklet contains much valuable information for millwrights and others concerned with the problems of power transmission in shops, mills and factories.

**Premier Machinery Co.**, Milwaukee, Wis. Circular of the "Hercules" combined milling machine, internal and external keyseater and gear cutter. The illustrations show how adaptable this little machine is to a large variety of work in the machine shop and how it can be applied to repair work requiring portability.

**Alfred Box & Co.**, Philadelphia, Pa. Bulletin of the Box wire rope hand crane, type B2R; bulletin of the Box jib crane, type AFC; bulletin 800 of electric traveling and jib cranes, illustrated with numerous examples of installations; and bulletin 1200 of monorail hoist types, illustrated with examples of installations.

**Lewis T. Kline**, Alpena, Mich. Catalogue of excelsior and wood-turning machinery, illustrating and describing machines for making excelsior, baling presses, wood splitters, cut-off saws, barkers, knife grinders, spur grinders, broom-handle machines, spool machines, plug machines, bolting saws, slitting saws, and wood-turning machinery in general.

**Mott Sand Blast Mfg. Co.**, 1157 E. 138th St., New York City. Four circulars relating to machinery and accessories for sandblasting, entitled respectively: "Direct-pressure Sandblast Machine, Hose Type"; "Sandblast Tumbling Barrel with Revolving Table and Cabinet, Type G"; "Sandblast Tumbling Barrel, Type P.V.S., Double"; and "Mott Sandblast Accessories".

**Wheeler Condenser & Engineering Co.**, Carteret, N. J. "Psychrometric Tables for Cooling Tower Work", being a small handbook for engineers which gives dry and wet bulb thermometer readings, dew point, humidity and pounds of water vapor per thousand cubic feet and per hundred pounds of air. This is a companion book to the company's "Steam Tables for Condenser Work".

**Thermalene Co.**, Chicago Heights, Ill. Booklet entitled "The Oxy-Thermalene Method of Welding and Cutting", describing the use of the so-called "thermalene" gas as a substitute for acetylene gas in autogenous welding and cutting of metals. The booklet illustrates and describes the apparatus used in connection with thermalene gas generation and the torches, etc., used in welding and cutting.

**Cooper Flexible Transmission Co.**, 8th Ave. and 18th St., Brooklyn, N. Y. Catalogue illustrating and explaining the design of the Cooper universal joint, shock-absorbing shaft, and flexible shafting. The design of the Cooper universal joint is based on a principle claimed to eliminate all irregularities in speed during the revolution of the shaft—irregularities which other universal joints are subjected to.

**Walker M. Levett Co.**, 10th Ave. and 36th St., New York City. Circular of "Magnalite" pistons for internal combustion engines. Magnalite pistons weigh one-third as much as cast-iron pistons of the same dimensions; thus their inertia effect is much less than that of cast-iron pistons. The claim is made that the thermal conductivity of magnalite is 14 to 1 as compared with cast iron, which has the effect of cooling the engine and promoting lubrication.

**Kerr Turbine Co.**, Wellsville, N. Y. Bulletin 54 on "Economy" turbo-alternators and generators, covering the advantages of turbine-driven generators in both large and small units, and describing and illustrating, by halftones and line engravings, a number of installations of these turbo-alternators and generators. An interesting chart showing relative space occupied by "Economy" turbines as compared with high-speed reciprocating engines or tandem compound reciprocating engines is included.

**Foxboro Co.**, Foxboro, Mass. Catalogue covering instruments made by the company. These instruments include tachometers; recording hygrometers; "Durand" radial planimeters; electric pyrometers; mechanical and electrical time-recorders; recording pressure and vacuum gages; siphon and mercury gages; revolution counters; thermographs; and various other precision instruments. The Foxboro instruments are manufactured by the Foxboro Co., but at the present time are sold by the Industrial Instrument Co., a subsidiary company.

**Cutler-Hammer Mfg. Co.**, Milwaukee, Wis. Loose-leaf catalogue relating to electric controlling devices. The catalogue covers both direct and alternating current motor starters and speed regulators, self starters and elevator controllers, as well as accessories and miscellaneous resistance units, rheostats, etc. It contains a great mass of tabulated data and important information, and is also characterized by the elimination of unessential material. The size is about 4 by 7 inches, making it handy for desk use and reference.

**Lea-Courtenay Co.**, Newark, N. J. Catalogue H-2 on centrifugal pumps, illustrating and describing the pumps manufactured by the company. The book is divided into a number of chapters covering general types of centrifugal pumps, indicating where each type is used; necessity of an efficient testing plant; inspection of parts; details of pump design and construction; single stage pumps for low and moderate heads; single-suction, multi-stage pumps; balanced pumps; double-suction, multi-stage pumps; pumps for boiler feeding; vertical multi-stage pumps; underwriters' fire pumps; and portable sinking pumps.

**J. E. Snyder & Son**, Worcester, Mass. 1915 catalogue of upright drilling machines, illustrating and describing the full line of Snyder upright drilling and tapping machines. The catalogue comprises about fifty pages and is arranged with the illustration of a drilling machine on the left-hand page and a brief description and general dimensions on the right-hand page, making the catalogue very convenient for reference. In all, twenty-three different types and sizes are illustrated and described and, in addition, drill chucks and drill sockets and sleeves for Morse taper shank drills are listed.

**American Blower Co.**, Detroit, Mich. Bulletin 6, describing and illustrating ABC steel plate exhaust fans, types E, L, and C. The bulletin describes in detail these fans, showing the construction by means of halftone illustrations and line engravings. The type E exhaust fan is designed especially for handling shavings, dust and refuse, or for any heavy material that will not be injured by passing through the fan. The types L and C fans are designed especially for cotton-gin work, but can also be used successfully for exhausting air or gas, and very light dust or waste material.

**Brown & Sharpe Mfg. Co.**, Providence, R. I. Booklet entitled "Apprenticeship", describing the apprenticeship system at the works of the Brown & Sharpe Mfg. Co., with the purpose of giving information as to what constitutes the learning of the machinist's trade at the Brown & Sharpe works, and explaining the entrance requirements, the conditions of service, and the lines of advancement that may follow a successful completion of an apprenticeship. The greatest emphasis is placed on the machinist's trade, but, in addition, apprentices are trained for drafting work, patternmaking, molding, coremaking, and blacksmithing. The book is profusely illustrated with halftone illustrations showing apprentices at work at various machines in the shop. The book is a valuable contribution to the literature on apprenticeship, giving an outline of what is now being done in up-to-date manufacturing plants.

## TRADE NOTES

**Ingersoll Milling Machine Co.**, Rockford, Ill., has changed the location of its Detroit, Mich., office from 827 Ford Bldg., to 806-808 Davis Whitney Bldg.

**W. S. Barston & Co., Inc.**, 50 Pine St., New York City, has reorganized its department of construction engineering with Arthur M. Porrey, formerly with Hildreth & Co., New York City, in charge.

**American Locomotive Co.**, 30 Church St., New York City, announces that at the meeting of the board of directors of the company held August 11, J. O. Hobby, Jr., was appointed treasurer of the company.

**Kempsmith Mfg. Co.**, Milwaukee, Wis., manufacturer of milling machines, is working night and day, and is now erecting an addition to the factory. The company will be in the market for considerable new equipment.

**Metals Coating Co. of America**, 122 S. Michigan Ave., Chicago, Ill., announces that the concern has opened an office at 100 Summer St., Boston, Mass., in charge of Herbert Jaques, Jr., who is prepared to furnish information and demonstrate the Schoop metal coating process to interested manufacturers.

**Rockford Tool Co.**, Rockford, Ill., has just completed a new shop, the dimensions of which are 126 by 126 feet. The company is now building a new 16-inch high-duty engine lathe in addition to its regular line, and will also shortly place a new gear-cutting machine on the market.

**Moltrup Steel Products Co.**, Beaver Falls, Pa., is erecting an addition to its plant for the production of finished crankshafts and other steel specialties. The addition is built of brick and concrete, and is 60 by 250 feet. The company also manufactures cold-drawn steel bars, machine keys and racks, and finished steel plate.

**Wilmarth & Morman Co.**, 1180 Monroe Ave., N. W., Grand Rapids, Mich., has broken ground for a large two-story modern brick addition to its present plant that will double the present floor space. A great deal of new equipment has been installed, and it is expected that the company will soon be able to make prompt deliveries on its grinding machines.

**Rockford Milling Machine Co.**, Rockford, Ill., has purchased the plant recently occupied by the Rockford Tool Co., in order to use this plant in connection with its present shops. A recent addition has also been made to the present plant, so that the available floor space is now more than doubled. The company intends to increase its line of milling machines.

**Duff Mfg. Co.**, Pittsburg, Pa., manufacturer of the Barrett lifting jacks, is building an extension to its main factory building, 150 feet by 125 feet in width. The main building with the extension will be 625 feet long by 125 feet wide. A five-ton bridge transfer crane and monorail conveying system is also being installed, together with considerable additional equipment.

**Fox Machine Co.**, 641 Front Ave., N. W., Grand Rapids, Mich., manufacturer of milling machines and multiple-spindle drills, contemplates removing from Grand Rapids to the southern part of the state. A new shop, 90 by 300 feet, is being erected, and a large foundry will also be constructed. The concern, at the present time, is working twenty-three hours a day.

**Clipper Belt Lacer Co.**, 1020 Front Ave., Grand Rapids, Mich., is erecting a large addition to its factory which will greatly increase the capacity. Mr. Foote, president of the company, recently returned from a business trip abroad which resulted in many large orders. During the early part of August one large order was booked for 14 tons of belt lacings and another for 5 tons.

**Cisco Machine Tool Co.**, Cincinnati, Ohio, has purchased the Von Wyck Machine Tool Co. at Elmore St. and C. H. & D. R. R., Cincinnati, and will make a number of improvements in the building and equipment. The officers are: H. C. Busch, president; James I. Stephenson, vice-president; James A. Sebastiani, secretary and treasurer; G. Mil. Horton, general manager.

**Webster & Perks Tool Co.**, Springfield, Ohio, and the Bauroth Machine & Tool Co., Toledo, Ohio, have consolidated. The machinery and equipment of the latter has been moved to Springfield and placed in improved manufacturing quarters. The additional equipment will materially increase the facilities of the Webster & Perks Tool Co., under whose name and management the consolidated business will be continued.

**Bullard Machine Tool Co.**, Bridgeport, Conn., has granted an eight-hour day without reduction of wages to its employes. The plant will be run twenty-four hours a day in three shifts of eight hours each. The working hours of the first shift will be from 7 A. M. to 3 P. M., the second shift starting at 3 P. M. and finishing at 11 P. M. The third shift will be a balancing shift to keep the various departments caught up and their production uniform.

**Thomas Coupling Co.**, Warren, Pa., will move its plant and offices to Troy, Pa., where a new shop is being erected. When completed, this plant will be up-to-date in every particular. The machinery equipment will consist of new machines throughout. The company has heretofore specialized on the Thomas "Little Giant" couplings for lineshafts, but in the new and enlarged quarters the manufacture of a complete transmission line will be undertaken.

**Pratt & Whitney Co.**, Hartford, Conn., announces that it has opened an office and show-room at 16-18 Fremont St., San Francisco, Cal. S. G. Eastman, formerly manager of the company's Chicago office, is in charge. A large stock of Pratt & Whitney machines, small tools and gages will be carried for the convenience of Pacific coast customers. The company has also been appointed agent for the entire line of the Niles-Bement-Pond Co.'s machine tools, cranes, steam hammers, etc.

**Mesta Machine Co.**, Pittsburg, Pa., is now building a complete line of hydraulic and steam hydraulic presses for piercing, drawing and forging. Fifteen of these presses were being put through the plant in July and August. The company is also making accumulators in various sizes in connection with hydraulic systems. One of these is exceptionally large in size and capacity, having a diameter of 32 inches and a stroke of 25 feet. It will deliver water to the press at a pressure of 2500 pounds per square inch.

**Western Kieley Steam Specialty Co.**, 116-122 W. Illinois St., Chicago, Ill., announces that a writ of injunction was issued June 23, 1915, by the Circuit Court of Cook Co., state of Illinois, perpetually enjoining James McAlear, Kieley & Mueller, Inc., and the Kieley Specialty Co. from using the name "Kieley Specialty Co.," or any other corporate, copartnership or other name or style which includes the name "Kieley" and the word "Specialty" in any combination in any manner whatsoever.

**Billings & Spencer Co.**, Hartford, Conn., has been elected to membership in the Rice Leaders of the World Association in recognition of its established reputation for conducting business as set forth in the association emblem and the qualifications for membership. The officers of the Billings & Spencer Co. are: C. E. Billings, president and general manager; F. C. Billings, vice-president and superintendent; Louis G. Parker, treasurer; E. H. Stocker, secretary; and F. H. Stocker, assistant secretary and treasurer.

**Universal Machinery Co.**, 1910-1920 St. Paul Ave., Milwaukee, Wis., announces that the concern has purchased the drawings, patterns, tools and equipment for the manufacture of lathes from 12 to 18 inches swing, with from 6- to 8-foot beds and over, and that a large quantity of these lathes, especially the 16-inch by 6-foot size, is now being completed. The company also announces that later it intends to manufacture a number of other classes of machine tools, including drill presses, grinders, turret lathes, and screw machines.

**George Schow**, Suite 717, 624 S. Michigan Ave., Chicago, Ill., has organized a foreign trade service bureau for the purpose of developing export trade to Europe. Mr. Schow, with assistants, will visit Russia, Norway, Sweden, Denmark, England and France to establish and organize a chain of sales agencies for leading American manufacturers. He has spent many years in the foreign field, having built several manufacturing plants in Europe and equipped them with American machinery and tools. He represented the Fox Machine Co., Grand Rapids, Mich., for the past ten years. A limited number of lines of machine tools will be handled, none of which will conflict.